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# SCIENCE

BUREAU OF CENSUS
NOV 18 2 4

SEPTEMBER 25, 1953

VOLUME 118 NUMBER 3065

## Contents

The Growth of Medical Research 1941–1953 and the Role of Public Health Service Research Grants: *Kenneth M. Endicott* and *Ernest M. Allen* ..... 337

### News and Notes

Abnormal and Pathological Growth in Plants: *R. S. Caldecott* and *T. T. Stonier* ..... 344

### Technical Papers

The Roles of Darkness and Light in the Activation of Avian Gonads: *D. S. Farner, L. R. Mewaldt,* and *S. D. Irving* ..... 351

A Simplified Method for Measuring Emotional Defecation in the Rat: *Dell Lebo* ..... 352

Stimulation of the Reticuloendothelial System with Choline: *John H. Heller* ..... 353

Increased Translocation of Plant-Growth-Modifying Substances Due to Application of Boron: *John W. Mitchell, W. M. Dugger, Jr.,* and *Hugh G. Gauch* ..... 354

A Transplantable Rat Lymphoma: *Margaret Reed Lewis* ..... 355

A New Articular Facet in the Upper Jaw of the Cyprinid Fish Genus *Pseudorasbora*: *L. S. Ramaswami* ..... 357

Synergism and Antagonism of Auxin by Antibiotics: *M. R. S. Iyengar* and *Robert L. Starkey* ..... 357

The Odors of Optical Isomers: *Harvey Posvic* ..... 358

### Comments and Communications

*J. K. Aiken; V. Korenchevsky; J. Murray Luck; F. P. Luduena; C. P. Martin* and *S. D. Mohiuddin; E. Percival; Roger W. Reed* and *Kenneth F. Gregory; Donald J. Reish; C. R. Szalkowski* and *W. J. Mader* ..... 360

### Book Reviews

*Dynamical Oceanography; Fundamentals of Limnology; Cold Spring Harbor Symposia on Quantitative Biology: The Neuron* ..... 365

**Scientific Book Register** ..... 366

**American Association of Physical Anthropologists** ..... 3

**Meetings & Conferences** ..... 10

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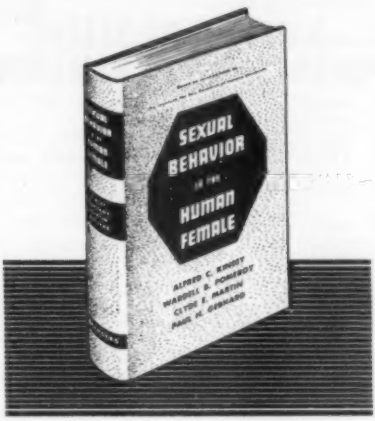


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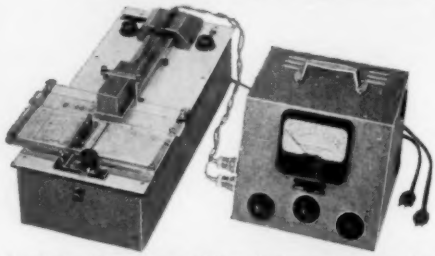

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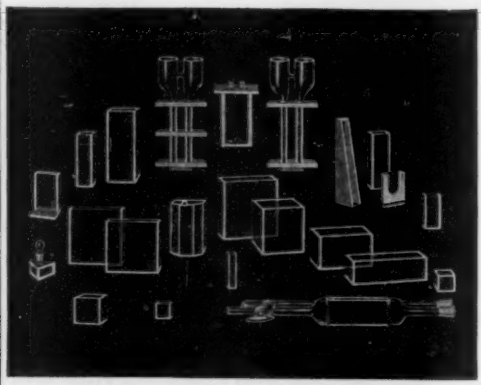

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Annual meetings are usually held in the spring, and often include a symposium of particular interest to the local sponsors. The next (23rd) meeting will be held March 26–28, 1954, at the Fels Research Institute for the Study of Human Development, Yellow Springs, Ohio. Since the War, the Wenner-Gren Foundation has sponsored a Summer Seminar in Physical Anthropology, first organized through the leadership of a former president, S. L. Washburn. The 1953 Seminar, arranged by W. M. Krogman and held in Boston at the Forsyth Dental Infirmary, discussed the role of physical anthropology in medical and dental research. Six earlier Seminars (see SCIENCE, 115: 230–231, February, 1952), have stressed the ways in which such fields as genetics, primatology, fossil man, race, growth, constitution, ecology, social biology, and applied physical anthropology, plus the technical fields of measurement and statistics, all tie together in the study of the evolution of man.

Association officers for the year 1953 are: president, William L. Straus, Jr., Professor of Physical Anthropology at Johns Hopkins University and 1952 winner of the Viking Fund Medal and Award; vice-president, Mildred Trotter, Professor of Anatomy at Washington University, St. Louis; secretary-treasurer, J. Lawrence Angel, Associate Professor of Anatomy and Physical Anthropology at Jefferson Medical College. The Executive Committee comprises Charles E. Snow, Professor of Anthropology at the University of Kentucky; Charles W. Goff, orthopedic surgeon in Hartford, Conn.; and T. Dale Stewart, Curator of Physical Anthropology at the U. S. National Museum. Representatives to the Council of the AAAS are W. Montague Cobb, Professor of Anatomy at Howard University, and William W. Howells, Professor of Anthropology at the University of Wisconsin and editor of our *Journal.*

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SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at the Business Press, 10 McGovern Ave., Lancaster, Pa. Entered as second-class matter at the Post Office at Lancaster, Pa., January 13, 1948, under the Act of March 3, 1879. Acceptance for mailing at the special rate postage provided for in the Act of February 28, 1925, embodied in Paragraph (d-2) Section 34.40 P. L. & R. of 1948.

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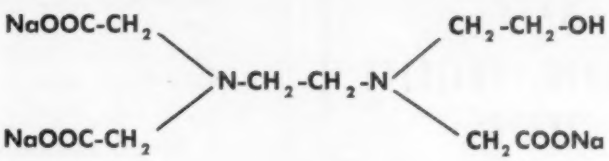


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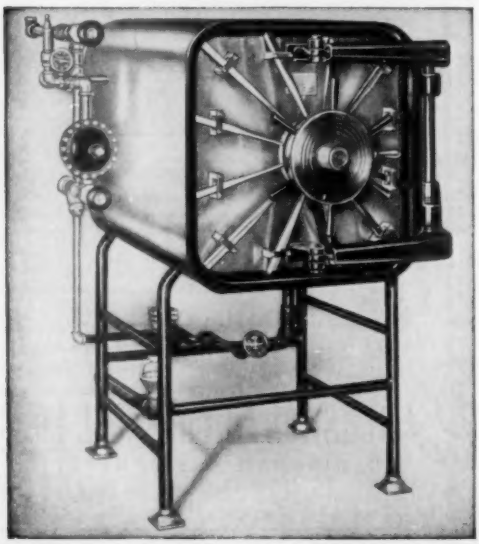

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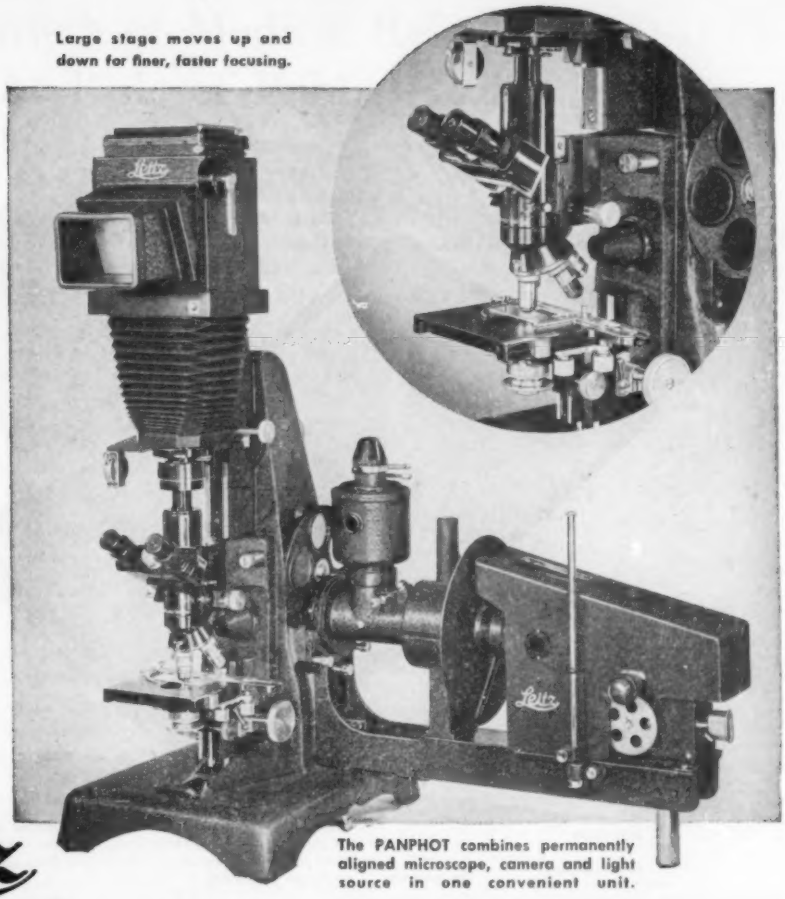

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# The Growth of Medical Research 1941-1953 and the Role of Public Health Service Research Grants

Kenneth M. Endicott and Ernest M. Allen

*Division of Research Grants, National Institutes of Health, Public Health Service, Department of Health, Education, and Welfare, Bethesda, Maryland*

SINCE THE BEGINNING of World War II, there has been considerable expansion of medical research in the United States. This expansion has been made possible by the diligent toil of many scientists, the vision and cooperation of hundreds of research institutions, and the generosity and enlightened self-interest of the millions of citizens who have borne the cost through gifts or taxes.

Realizing that many persons would share our interest in the magnitude, cost, and results of this expansion as well as in the role played by the Public Health Service research grants program, we wish to present here some aspects of the development.

## Total Expenditures for Medical Research in the United States

Some measure of the magnitude of medical research is reflected in cost figures. Though precise cost figures are not available, it has been estimated (*1*) that the total expenditure for medical research in the United States increased from an annual rate of $18,000,000 in 1941, to $115,000,000 in 1946, and to $181,000,000 in 1951. Thus, the total annual expenditures, uncorrected for inflation, increased tenfold in a decade. It is important to note (Fig. 1) that the sources of the funds also changed to a marked degree. The Federal Government, a very minor contributor in 1941, provided $28,000,000 in 1946 and $76,000,000 in 1951. Industry provided $55,000,000 in 1946 and $60,000,000 in 1951. Contributions from all other sources, including foundations, were $32,000,000 in 1946 and $45,000,000 in 1951.

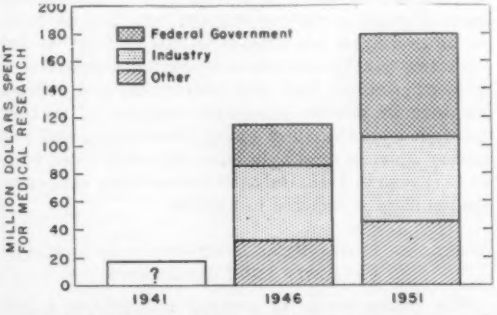


FIG. 1. Increase in total expenditure for medical research in the U. S., 1941–1951.

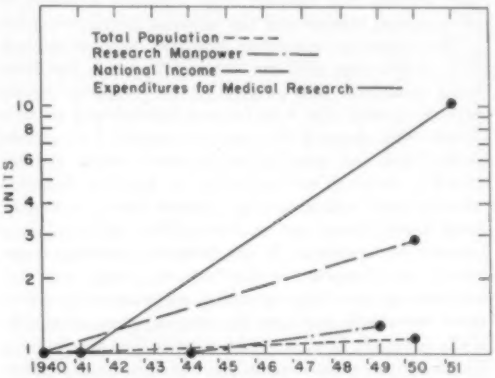


FIG. 2. Growth rate of population and the national income in the U. S. in comparison with trends in expenditures for medical research and trained medical research manpower, 1940–1951.

## Medical Research Manpower

The total trained manpower for medical research in the United States has never been determined, but considerable information can be obtained by the study of various listings and rosters, such as *American Men of Science* (*2*). In the 1944 edition, 5665 non-Federal, nonindustrial medical scientists were listed. The number had increased 29.66% to 7345 in the 1949 edition. Of these 7345 scientists, 5391 were associated with medical schools and 1954 had various other affiliations. In addition, there were 825 listed in Federal Government services and 838 in industry, making a total of 9008.

The rate of increase of trained research manpower is probably considerably greater than these figures indicate because of the delay between completion of training and the achievement of sufficient scientific stature to be listed in *American Men of Science*.

## Medical Research as a National Effort

In Fig. 2, on semilogarithmic scale, there is shown the crude growth rate of the population and the national income in comparison with trends in expendi-

tures and trained manpower in medical research. It is evident that medical research manpower has increased more rapidly than the general population, and that expenditures for medical research have increased at a greater rate than national income.

Our estimates indicate that 0.024 per cent of the national income was spent for medical research in 1940, with an increase by 1950 to 0.074 per cent. By extrapolation over the same time period, the percentage of the population holding senior medical research positions increased from 0.0035 per cent in 1940 to 0.0051 per cent in 1950. The national medical research effort, in spite of an accelerated expansion over the past decade, still absorbs only a minute fraction of the national income and the national manpower pool.

The expansion continues, however, without perceptible slackening, and the demand appears far from being satisfied. The availability of research money attracts young men who become trained and in turn create more demand for research money. Educational institutions and hospitals that never before participated in research are beginning to appoint research-minded staff members who attract research money, train young men, and so forth. This self-catalyzing process has continued in the face of a national emergency, and despite the drafting of young men for military service. Fund-granting agencies receive ever more numerous requests for the support of worthwhile research. It thus would appear that the limiting factor in the current expansion has been money rather than manpower.

## Trends in Volume and Types of Research, Sources of Published Papers, and Sources of Support

We have found it most difficult to obtain accurate information on research work in progress. The excellent paper by Deignan and Miller (*3*) gives valuable data on perhaps a 20 per cent segment of the work in progress, but contains no information on research supported within the given institution. Thus, there are no data on work in industry and in Government laboratories, or on work supported by hospitals, universities, or local donors.

TABLE 1

Sources of Publications in Medical Science

| Source | 1948 | | 1951 | | Change between 1948 and 1951 | |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % |
| Universities and colleges | 2929 | 65.71 | 3750 | 66.92 | +821 | +28.03 |
| Research foundations | 242 | 5.43 | 289 | 5.16 | + 47 | +19.42 |
| Hospitals | 410 | 9.19 | 448 | 8.00 | + 38 | + 9.27 |
| Commercial laboratories | 220 | 4.93 | 197 | 3.51 | − 23 | −10.45 |
| Government laboratories | 393 | 8.82 | 588 | 10.50 | +195 | +49.62 |
| Other | 264 | 5.92 | 331 | 5.91 | + 67 | +25.38 |

TABLE 2

Acknowledged Financial Support of Medical Publications Originating in Universities and Colleges

| Source of support | No. of papers 1948 | No. of papers 1951 |
|---|---|---|
| U. S. Public Health Service | 369 | 935 |
| Other Federal agencies | 309 | 368 |
| Foundations and voluntary agencies | 725 | 799 |
| Commercial | 197 | 148 |
| Other | 21 | 62 |
| No acknowledgment | 1308 | 1437 |
| Total | 2929 | 3729 |

In order to obtain a broader sample of the total effort, we have analyzed the publications in 36 leading research journals for the years 1948 and 1951. In 1948 there were 4458 articles, and in 1951 the number had increased 20.45 per cent to 5604. Each journal published more articles in 1951 than in 1948, and most journals showed a greater backlog in 1951 (as judged by the interval between receipt of manuscript and publication). This indicates a greater volume of research in all the basic sciences as well as in most clinical fields.

The changing pattern of distribution of research effort is indicated in Table 1. Educational institutions are increasing their lead in volume of publications, and Government laboratories appear to be moving into second place at a rapid rate. Papers from commercial laboratories have decreased in number whereas from all other sources papers have increased.

Colleges and universities receive a considerable but unknown portion of the financial support of their research through grants and contracts. We therefore recorded the acknowledgments of grant or contract support mentioned in those papers coming from colleges and universities (Table 2). This study confirms the growing importance to universities of Federal support in medical research. The absence of acknowledgment of grant or contract support may, in some cases, be an oversight; but since it is true that grants and contracts usually provide only partial support of a project, it seems clear that universities and colleges continue to provide substantial support of medical research from their own funds. Foundations and voluntary agencies appear to have supported more work in 1951 than in 1948. Only the commercially supported studies show a decrease in number.

## Trends in Geographical Distribution of Research Manpower and Publications

The concentration of medical research in a few centers has long been recognized and the undesirable consequences of such concentration have been pointed out by many writers. We have therefore examined the geographical distribution trends with particular in-

TABLE 3

GEOGRAPHICAL DISTRIBUTION OF NON-FEDERAL NONINDUSTRIAL MEDICAL SCIENTISTS BASED ON *American Men of Science* LISTINGS

| Area | States | 1944 Edition | | 1949 Edition | | Increase | |
|---|---|---|---|---|---|---|---|
| | | No. | % | No. | % | No. | % |
| New England | Me., Vt., N. H., Mass., R. I., Conn. | 651 | 11.49 | 774 | 10.54 | 123 | 18.89 |
| Middle Atlantic | N. Y., Pa., N. J. | 1556 | 27.47 | 1942 | 26.43 | 386 | 24.81 |
| South Atlantic | Del., Md., D. C., Fla., Va., W. Va., N. C., S. C., Ga. | 712 | 12.56 | 841 | 11.45 | 129 | 18.12 |
| East North Central | O., Ind., Ill., Mich., Wis. | 1109 | 19.57 | 1451 | 19.76 | 342 | 30.84 |
| East South Central | Ky., Tenn., Miss., Ala. | 196 | 3.46 | 207 | 2.82 | 11 | 5.61 |
| West North Central | Minn., Ia., Mo., N. D., S. D., Neb., Kan. | 610 | 10.77 | 828 | 11.27 | 218 | 35.74 |
| West South Central | Ark., La., Okla., Tex. | 266 | 4.70 | 351 | 4.78 | 85 | 31.95 |
| Mountain | Mont., Ida., Wyo., Nev., Utah, Colo., Ariz., N. Mex. | 117 | 2.07 | 181 | 2.46 | 64 | 54.70 |
| Pacific | Wash., Oreg. Calif. | 448 | 7.91 | 770 | 10.49 | 322 | 71.88 |
| Total | | 5665 | 100.00 | 7345 | 100.00 | 1680 | 29.66 |

terest. From the standpoint of scientific manpower we find that the most rapid rates of increase are not in the old well-established institutions of the East, but rather in other institutions and areas (Table 3). To what extent the redistribution of manpower may be due to local interest or to policies of large granting agencies remains unknown, but it seems likely that local initiative has been an important factor. Not all geographic areas have been equally successful in attracting scientific manpower. Some appear to have the desire but to lack the funds, and vice versa. In this connection, it is interesting to compare the distribution of population and per capita income (Table 4) with the distribution of research manpower. One sees a tendency toward proportionality, but there are exceptions even on the basis of large geographical areas. If one examines the record, state by state, one finds even greater disproportions, so that some rather populous states with better than average per capita income have almost no trained medical research manpower as we have measured it.

TABLE 4

COMPARISON OF MEDICAL RESEARCH MANPOWER WITH POPULATION AND PER CAPITA INCOME BY GEOGRAPHICAL AREA

| Area | AMS listings, 1949 (%) | Population, 1950 (%) | Thousand population per AMS listing | Per capita income |
|---|---|---|---|---|
| New England | 10.54 | 6.18 | 12.03 | $1554 |
| Middle Atlantic | 26.43 | 20.01 | 15.53 | 1717 |
| South Atlantic | 11.45 | 14.06 | 21.16 | 1137 |
| East North Central | 19.76 | 20.17 | 20.95 | 1603 |
| East South Central | 2.82 | 7.62 | 55.45 | 865 |
| West North Central | 11.27 | 9.33 | 16.98 | 1387 |
| West South Central | 4.78 | 9.65 | 41.29 | 1144 |
| Mountain | 2.46 | 3.37 | 28.04 | 1358 |
| Pacific | 10.49 | 9.61 | 18.81 | 1709 |
| Averages | | | 20.42 | $1436 |

This maldistribution may possibly be due to an error in measurement, but we have considerable confidence in the general reliability of this manpower sampling method because the results show a high degree of correlation (0.92–0.98) with other analyses we have made on rosters maintained by the Office of Education and the Office of Defense Mobilization. There are obvious reasons, of course, why one must not assume that all medical scientists listed in *American Men of Science* are equally productive in research. The men listed may be assumed to meet certain minimum standards since the listings are developed with the guidance of the national professional scientific societies and are based on educational background, publications, academic position, and scientific reputation.

It is well known, however, that even though the Ph.D. candidate must demonstrate some research ability in his thesis work, he may lose interest in research or may have so many other duties that he is unable to continue his research in an academic or other position. The M.D. with his training directed primarily toward the practice of medicine rather than research is not always trained in research, even though he may be a renowned professor.

One should therefore take into account such factors as research ability, research interest, research opportunity, and research facilities. These factors cannot readily be measured directly, but inasmuch as they play an important role in determining whether a man publishes research papers, they can be measured indirectly by enumeration of scientific publications. We realize that when such a measurement is applied to a single investigator it means little, for one man

may write much and contribute little of importance, whereas another man may write but one paper and yet make a major contribution. As the number of scientists involved increases, however, the importance of this individual variation diminishes, so that, for a large geographical area with many scientists, the number of papers written in a given period becomes quite significant. It is believed that the accuracy of the method is further increased by limiting the enumeration to the highly reputable national scientific periodicals which screen papers carefully before accepting them for publication. Accordingly, 53 such periodicals were analyzed and the 13,911 articles were tabulated according to the institution of origin. The results are summarized in Table 5, which shows the comparative percentages in 1940 and 1950.

TABLE 5

GEOGRAPHICAL ORIGIN OF ARTICLES APPEARING IN LEADING MEDICAL SCIENTIFIC PERIODICALS

| Area | Articles appearing in 50 periodicals, 1940 (%) | Articles appearing in 53 periodicals, 1950 (%) |
|---|---|---|
| New England | 13.54 | 13.29 |
| Middle Atlantic | 31.28 | 27.80 |
| South Atlantic | 10.31 | 10.52 |
| East North Central | 19.88 | 21.18 |
| East South Central | 3.29 | 2.37 |
| West North Central | 9.43 | 8.61 |
| West South Central | 3.93 | 4.52 |
| Mountain | 1.20 | 2.01 |
| Pacific | 7.10 | 9.69 |

When the distribution of sources of publications is compared with the distribution of scientific manpower, it is noted that some areas appear more productive, man for man, than others. The ratio between percentage of publications and percentage of men in 1950 varies from 0.82 in the Mountain States to 1.26 in the New England States. When the ratio is determined for individual universities the variation is much more striking—0.14 for the lowest and 1.71 for the highest. Anyone familiar with the great variation from one school to another in amount of research activity will not be surprised at this twelvefold difference.

## RESEARCH POTENTIAL

In view of these major differences in productivity it is obviously necessary to adjust manpower figures if one wishes to consider research potential. Reynolds and Price (*4*) developed a useful index of research potential based on manpower, publications, advanced degrees, approved residencies, and other factors. They subsequently found that essentially the same index could be obtained by considering only manpower and publications. The index is obtained by the formula:

$$\%\ \text{Research Potential} = \frac{\%\ \text{AMS Listings} + \%\ \text{Publications}}{2}$$

Using this formula, we have calculated the distribution of research potential for the years 1940 and 1950 (Table 6).

TABLE 6

MEDICAL RESEARCH POTENTIAL IN NON-FEDERAL INSTITUTIONS BY GEOGRAPHICAL AREA

| Area | R. P. 1940–44 (%) | R. P. 1949–50 (%) |
|---|---|---|
| New England | 12.51 | 11.92 |
| Middle Atlantic | 29.37 | 27.12 |
| South Atlantic | 11.44 | 10.99 |
| East North Central | 19.73 | 20.47 |
| East South Central | 3.38 | 2.60 |
| West North Central | 10.10 | 9.94 |
| West South Central | 4.32 | 4.65 |
| Mountain | 1.64 | 2.23 |
| Pacific | 7.51 | 10.08 |

These figures demonstrate that some redistribution of research potential has occurred, but the striking changes are obscured by the fact that all these geographic areas contain institutions that are growing in research potential at widely different rates. If one considers individual medical schools, the changes are more striking. Reynolds and Price (*4*) arranged the medical schools in descending order of research potential and recorded the results in groups of ten. We have used their same grouping and brought the re-

TABLE 7

CHANGES IN RELATIVE MEDICAL RESEARCH POTENTIAL IN INSTITUTIONS HAVING MEDICAL SCHOOLS

| Group | R. P. 1940–44 (%) | R. P. 1949–50 (%) | Increase (%) |
|---|---|---|---|
| 1st ten | 27.91 | 28.22 | 1 |
| 2nd ten | 14.38 | 15.94 | 11 |
| 3rd ten | 7.63 | 7.72 | 1 |
| 4th ten | 5.52 | 6.56 | 19 |
| 5th ten | 4.04 | 4.25 | 5 |
| 6th ten | 2.99 | 3.70 | 24 |
| 7th ten | 2.03 | 3.39 | 67 |
| Last eight | 0.98 | 1.75 | 79 |
| Total | 65.48 | 71.53 | |

TABLE 8

MEDICAL SCHOOLS MOVING UP MOST RAPIDLY IN RESEARCH POTENTIAL RANK ORDER BETWEEN 1944 AND 1950

| School | Increase in rank order |
|---|---|
| Univ. Utah | 43 |
| Univ. Washington | 27 |
| Syracuse Univ. | 24 |
| New York Medical College | 19 |
| Southwestern Medical School | 18 |
| College Medical Evangelists | 17 |
| Emory Univ. | 16 |
| Univ. Indiana | 14 |
| Boston Univ. | 13 |
| Tufts College | 11 |
| Bowman-Gray | 11 |
| Univ. Alabama | 10 |
| Univ. So. Calif. | 9 |
| Univ. Texas | 8 |

sults up to date in Table 7, which shows that schools toward the bottom of the Reynolds-Price list had the most rapid increase in research potential. Increases at some schools have occurred at such a rapid rate that if a new list based on the more recent rating is made, it is found that eleven schools have moved up more than ten places. The University of Utah, for example, moved up 43 places; the University of Washington, 27 places; and Syracuse University, 24 places. The schools showing the greatest increases are listed in Table 8.

### Comments on the General Picture

From the evidence presented in the preceding sections, it seems justifiable to conclude that in the decade from 1940 to 1950 medical research made rapid strides in the United States. Expenditures increased about tenfold; the Federal Government emerged as a major source of financial support; the pool of trained manpower increased considerably as did also the rate of scientific publications. Powerful new foci of research appeared, and the tendency to concentrate medical research in perhaps a dozen large centers was reversed as research activity increased across the land.

Many factors have worked to bring about these changes, such as unprecedented prosperity, military necessity, and education of the general public to the value of research. With growing public understanding has come growing public support both through voluntary agencies, such as the American Cancer Society, and through tax-supported agencies, such as the Public Health Service.

### Development of the Public Health Service Research Grant Programs

Although the Public Health Service awarded a few grants for cancer research every year from 1937 on, the broad program began in 1946 with the transfer of 50 projects from the Office of Scientific Research and Development when that agency was dissolved. The new program had as its objective the improvement of the nation's health through the acquisition of new knowledge in all the sciences related to health. In the sense that the new knowledge is sought for the purpose of improving health this program is one of applied research, but many of the grantees consider their projects basic. Those who established the program believed that maximum progress can be achieved only if the scientists enjoy freedom to experiment without direction or interference, and they drew up policies and procedures accordingly. The decision as to which applications are approved rests with committees of non-Government scientists, who serve also to develop policies designed to meet changing needs. The investigator works on problems of his own choosing and is not obliged to adhere to a preconceived plan. He is free to publish as he sees fit and to change his research without clearance if he finds new and more promising leads. He has almost complete budget freedom as long as he uses the funds for research purposes and expends them in accordance with local institutional rules. Progress reports are required only once a year and are used chiefly as the tool for evaluation of renewal applications. Title to equipment purchased with grant funds is vested in the grantee institution and remains with that institution upon termination of the grant. Once a grant is made, there is no direction or interference on the part of Government.

Some control of the subject matter distribution of research, however, is implicit in a competitive project system since there are always more applications than there are funds, and by choosing which projects are to be supported, one sets the general pattern to some extent. In addition, Congress imposes a degree of control and direction when it appropriates funds earmarked for research on a designated disease or a specific organ. The extent to which funds have been earmarked is shown in Table 9. Here it is seen that in 1953 about 80 per cent is earmarked. In actual practice, however, it has been possible to provide reasonably equal opportunity for scientists regardless of their specialty in the health field, since the earmarked areas are broad and overlap to a considerable degree, especially with regard to the basic medical sciences.

In the eight years since the program began, more than 14,000 applications have been received covering

TABLE 9

NIH* Research Grants Appropriations by Fiscal Year

| Field | 1945 | 1946 | 1947 | 1948 | 1949 | 1950 | 1951 | 1952 | 1953 |
|---|---|---|---|---|---|---|---|---|---|
| Cancer | 85,030 | 76,900 | 515,000 | 2,599,635 | 3,300,000 | 2,600,000 | 3,129,079 | 3,100,000 | 4,920,000 |
| General | | 703,258 | 2,922,280 | 5,901,163 | 7,025,492 | 5,570,000 | 5,108,645 | 4,305,000 | 4,255,000 |
| Mental health | | | | 373,665 | 546,000 | 794,000 | 1,198,628 | 1,663,000 | 1,662,000 |
| Heart | | | | | | 3,820,000 | 4,327,479 | 4,809,000 | 5,150,000 |
| Dental | | | | | | 200,000 | 218,400 | 221,000 | 221,000 |
| Arthritis and metabolic diseases | | | | | | | 695,395 | 1,345,000 | 1,345,000 |
| Neurological diseases and blindness | | | | | | | 342,708 | 1,015,000 | 965,000 |
| Microbiology | | | | | | | 1,353,794 | 1,950,000 | 1,950,000 |
| Total | 85,030 | 780,158 | 3,437,280 | 8,874,463 | 10,871,492 | 12,984,000 | 16,374,128 | 18,408,000 | 20,468,000 |

* National Institutes of Health—the Bureau of the Public Health Service responsible for the administration of the research grants program.

every major scientific area related to health (Fig. 3). More than 7000 grants have been awarded, totaling nearly $100,000,000. The amount of support in specific scientific fields has been reported elsewhere and need not be repeated here. Suffice it to say that, in general, the distribution pattern of the grants corresponds closely with that of the applications and covers every active area of health research.

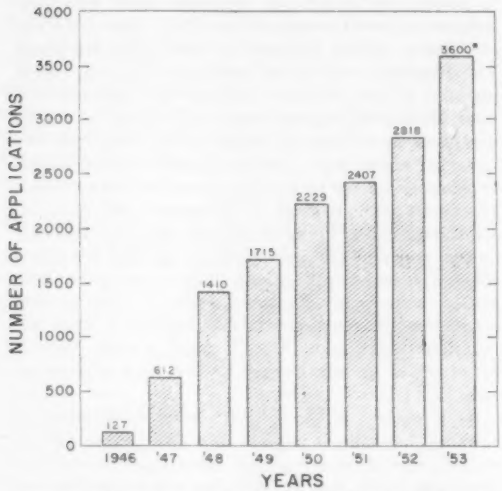


FIG. 3. Increase in applications for Public Health Service Research Grants received during 1946–1953. * Estimated on basis of receipts to date.

## GEOGRAPHICAL DISTRIBUTION OF PUBLIC HEALTH SERVICE RESEARCH GRANTS

Since this program seeks better health through research, it has been assumed that the geographical location of the scientist is of minor importance compared with the originality of his proposal and his ability as an investigator. Decisions on projects to be supported have therefore been made on the basis of individual merit. Other things being equal, one would predict that the aggregate result would be a grant distribution pattern similar to that of research potential. Reynolds and Price found this to be true from 1946 to 1949. The results from 1949 to 1952 are similar (Fig. 4). Only the New England States depart significantly from the expected pattern: they receive about 16 per cent of the funds and possess about 13 per cent of the research potential. All other areas are within 2 per cent of the expected pattern.

When funds requested are compared with funds granted (Fig. 5), the correlation is excellent. Thus it appears that the selection system is free of geographical bias. As research potential has shifted, the distribution of funds has shifted accordingly. Much has been written regarding the tendency of all granting agencies to concentrate their awards in the large well-established universities. Figure 6 indicates that the

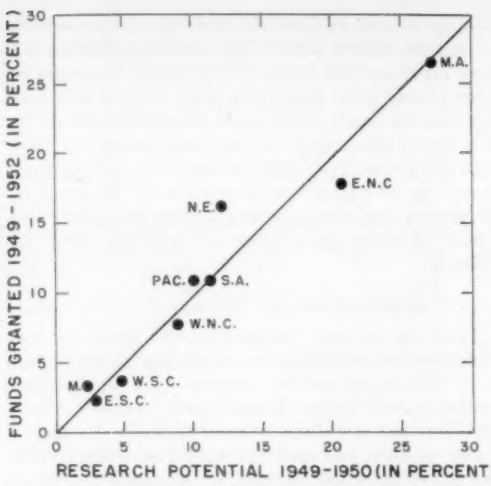


FIG. 4. Geographic distribution of Public Health Service Research Grant Funds awarded, 1949–1952, in comparison with geographic distribution of research potential, 1949–1950.

Public Health Service program shows this tendency to a slight degree. Thus 35 per cent of the funds went to the top ten schools which have, according to our calculations, 29 per cent of the research potential.

## ROLE OF PUBLIC HEALTH SERVICE RESEARCH GRANTS IN THE COUNTRY'S MEDICAL RESEARCH

One can only speculate as to what the developments might have been if the Public Health Service research grants program had not been established, but it seems obvious that a rapid expansion of effort in medical

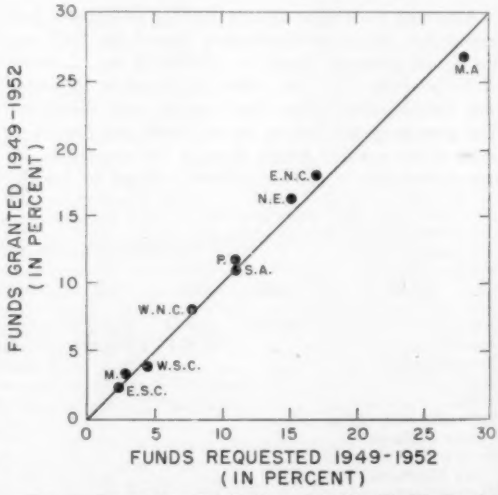


FIG. 5. Geographic distribution of Public Health Service Research Grant Funds requested, in comparison with distribution of funds granted, 1949–1952.

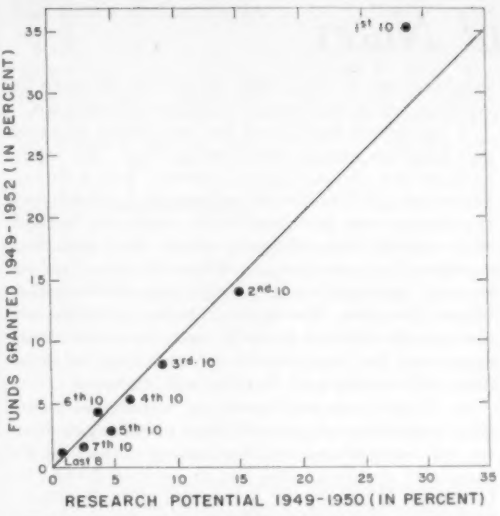


FIG. 6. Comparison of Public Health Service Research Grant Funds awarded, 1949–1953, with research potential, 1949–1950, in schools ranked according to descending order of research potential.

research was inevitable at the end of the World War II. Military necessity had required the initiation of the expansion and had set into motion the buildup of manpower, facilities, and the interest of the academic scientists. The general public, deeply impressed by the success of atomic research, manifested its desire to support medical research by establishing and giving generously to a number of voluntary associations.

In this expanding framework the Public Health Service program has served as only one of many sources of support. Thus, Deignan (*3*) reports that in 1951 the national foundations, voluntary agencies, and the Federal Government provided $32,893 in grants and contracts for medical research. Of this amount, about $22,000,000 came from Government, of which Public Health Service grants were $16,000,000. The remaining $11,000,000 came from private sources. In that same year, grants and contracts actually constituted only 18 per cent of the total expenditures for medical research ($181,000,000), so that the Public Health Service research grant program constituted only 8.8 per cent of the total support.

Despite the fact that, by percentage, the program was only 8.8 per cent, its effects were considerable. For example, of the medical research publications originating in universities and colleges in 1951, nearly 25 per cent acknowledged partial support by Public Health Service research grants. It is important to note that in most instances PHS support was only partial. The grants have averaged less than $9000 and have usually provided salaries for an assistant or two along with some equipment and supplies. Only rarely (less than 1.6 per cent of the funds) has a grant provided salary of the principal investigator and in no instance has a grant provided the total cost of a project. Thus the program has been of greatest assistance to those institutions that were willing and able to employ and provide basic facilities for competent scientists. By supplementing local support in this way the Public Health Service research grant program has served to make possible the increased usefulness of existing manpower and facilities.

In addition to utilizing existing manpower, the program has contributed to the training of many new scientists who received training while they were employed on grant funds. The magnitude of this training aspect can be inferred from the fact that 35 per cent of the funds, or nearly $35,000,000, was spent by grantees to employ professional assistants between 1946 and 1953. Many of these former assistants are now grantees themselves.

Another major effect of the program has been to help stimulate research in neglected fields—particularly research on some of the chronic diseases. From the over-all standpoint, however, perhaps the most important function of the program is that of a balance wheel. It serves at a national level to provide research opportunity on an individual basis to a large segment of the trained manpower pool for the work which the scientist himself wants most to do.

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# News and Notes

## Abnormal and Pathological Growth in Plants

THE sixth annual symposium sponsored by the Biology Department of Brookhaven National Laboratory was held at the laboratory, August 3–5, 1953. The subject of this year's conference was abnormal and pathological growth in plants. It included a brief review of normal growth requirements, tissue culture studies on normal and abnormal tissues, and more detailed considerations of various atypical and pathological growths such as hereditary tumors, insect galls, bacterial tumors, and virus- and radiation-induced abnormalities.

In the first paper, F. Skoog discussed the chemical factors influencing normal growth with particular emphasis on the effect of indoleacetic acid on nucleic acid synthesis and the morphogenetic importance of the indoleacetic acid/adenine ratio.

The use of *in vitro* cultures for investigating the nutritional and morphogenetic aspects of normal and pathological growth and differentiation was considered by several of the participants. A. J. Riker and A. C. Hildebrandt presented data from an extensive series of experiments on the carbohydrate and nitrogen nutrition of several types of crown gall tissue. L. G. Nickell reviewed the nutritional requirements of virus tumor tissue and the effects on such tissue of certain growth stimulating substances and mitotic inhibitors.

The inhibition of sunflower tissue, with particular reference to the action of folic acid derivatives, was discussed by R. S. De Ropp. It was demonstrated by R. Wetmore that fern apices grown *in vitro,* with nitrate as the sole nitrogen source, have the capacity to reconstitute an entire plant. In contrast, angiosperm apices required more complex nitrogen sources. To elucidate this difference in nitrogen requirements, considerable data were obtained on the amino acid contents of developing lupin plant organs.

C. D. La Rue reported on the atypical growth potentialities shown by *in vitro* cultures of haploid tissue—Cycad female gametophytes and various gymnosperm male gametophytes, diploid tissue—various isolated plant organs, and of triploid tissue—the endosperm of maize.

In a review by R. Bloch, the different types of atypical and pathological plant growth were classified according to the outline of Küster. The developmental pattern of these growths and factors influencing their formation were discussed in detail by the subsequent speakers. A. E. Kehr gave an inclusive description of the hereditary tumors produced by many of the *Nicotiana* hybrids. It was observed that spontaneous tumor formation occurs at the seedling stage and again following production of flowers, presumably at times of metabolic stress when the influence of a genetic imbalance can be manifested. E. G. Beck discussed the *Solidago* gall as an example of insect-induced galls.

A theoretical analysis of the mechanism of crown gall induction was presented by R. Klein. This report contained two items of special interest: first, a desoxyribonucleic acid fraction of pathogenic *Agrobacterium tumefaciens* was described which transforms bacteria of a related nonpathogenic strain into organisms capable of causing tumors; second, bacteria-free extracts of pathogenic cultures were reported to initiate tumor formation. The tumor-inducing principle was shown to be different from the bacterial-transforming agent, and the possibility of its containing an active desoxyribonucleic acid fraction was discussed.

A. C. Braun demonstrated the capacity of tumor cells to revert to normal cells, thus providing evidence for the concept that self-duplicating entities in the cytoplasm are responsible for, or associated with, the properties of tumor cells. Evidence against the theory that crown gall is a virus disease was discussed.

A review of the initiation, development, and final degeneration of leguminous root nodules was given by O. N. Allen. The curious behavior of the invading bacteria and the rigidly defined morphology of the galls were described in detail.

L. M. Black outlined a technique for isolating the wound-tumor virus by differential sedimentation and presented data on its size and shape secured from electronmicroscope studies. In a review of virus-induced growth abnormalities, L. O. Kunkel showed the profound influence and wide spectrum of structural changes that can be caused by virus infection.

A strikingly similar spectrum of aberrancies resulting from exposure to chronic gamma irradiation was reported by J. E. Gunckel and A. H. Sparrow. It was pointed out that radiation merely seemed to increase the frequencies of growth abnormalities found in unirradiated populations. S. Shapiro discussed the pattern of adventitious bud regeneration from stem segments and presented evidence that x-rays reverse the normal polarity of bud production. It was suggested that this effect may be due to the availability of auxin in different parts of the irradiated cutting.

The following moderators deserve much credit for evoking considerable discussion of the papers presented: K. V. Thimann, E. Ball, A. F. Blakeslee, A. E. Dimond, R. F. Dawson, P. R. White, I. F. Lewis, and H. J. Curtis. The list of participants is too long to be published here but much of the success of the symposium may be attributed to the thought-provoking comments following each paper. The papers and discussions will be published in the near future by Brookhaven National Laboratory.

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## Scientists in the News

Smith, Kline & French Laboratories of Philadelphia has two new staff members. **Kaymond C. Bard,** formerly Assistant Professor of Bacteriology at Indiana University, has joined the company as Head of the Microbiology Section, and **Joseph V. Swintosky** resigned from his post at the University of Wisconsin to become a Senior Pharmacist in the firm's Pharmaceutical Chemistry Section.

**Francis Birch** has been appointed Chairman of the Division of Earth Sciences (formerly Division of Geology and Geography) of the National Research Council, Washington, D.C., for the year 1953–54. Dr. Birch, Sturgis-Hooper Professor of Geology at Harvard University, is also chairman of the Committee on Experimental Geology and Geophysics at Harvard. He is well-known in the field of geophysics for his work on geothermal gradients and properties of materials at high pressures and temperatures.

**Earle Buckingham,** Professor of Mechanical Engineering at the Massachusetts Institute of Technology, has retired. He will continue this fall as Emeritus Professor of Mechanical Engineering and as a lecturer. After attending the U.S. Naval Academy, Prof. Buckingham served as mechanical engineer with a number of New England manufacturing firms. In 1925 he joined the M.I.T. Department of Mechanical Engineering as Associate Professor of Engineering Standards and Measurements, and in 1931 he became Professor of Mechanical Engineering.

Prof. Buckingham is the author of several books on gearing and manufacturing problems, and is a member of the Society of Automotive Engineers and the American Society of Mechanical Engineers. In 1950 he was honored by the American Gear Manufacturers Association with the Edward P. Connell award.

**Arthur H. Burr,** Head of the Department of Machine Design in the Cornell University College of Engineering, is spending a sabbatical year at the Institute of Aeronautics in the Brazilian government's Aeronauties Center in São José dos Campos, São Paulo. Prof. Burr has been asked to reorganize the Institute's courses in machine design, drawing, and engineering mechanics.

**Herbert L. Davis,** formerly associated with Ethicon Suture Laboratories, has joined the staff of Wayne County General Hospital, Eloise, Mich., as an Associate in Surgical Research. He is conducting studies on fat embolism and other applications of colloid chemistry in medicine.

**Marjorie W. Evans,** a physical chemist, has joined the staff of the Department of Chemistry at the Stanford Research Institute. She was formerly at the Armour Research Foundation, Chicago, where she was a consultant on problems of thermodynamics, combustion, and explosion.

**H. R. Gault** has accepted appointment as Executive Secretary of the Division of Earth Sciences, National Research Council. Dr. Gault is on leave of absence from Lehigh University where he is a professor of geology.

The Thurman H. Bane Award, given annually by the Institute of Aeronautical Sciences to an Air Force officer or civilian for an outstanding achievement in aeronautical development, has been awarded for 1953 to **Benjamin F. Greene, Jr.** of the Air Force Cambridge Research Center, Cambridge, Mass. Mr. Greene was cited "for the development of an electronic system for airport traffic control which greatly increases the landing rate of aircraft under high density traffic or poor visibility conditions."

The University of Rochester has announced the appointment of four scientists to posts in the Physics Department. **Everett Hafner,** a member of the Brookhaven National Laboratory staff who has been at Cambridge University, England, this past year, will become a research associate. **Malcolm Savedoff** of Princeton University and the Mt. Wilson Observatory has been made a research associate and part-time professor. Dr. Savedoff, who recently returned from a year at the Leiden Observatory, Netherlands, will be engaged in research which is supported by the Office of Naval Research. **Jean Crussard** of the Ecole Polytechnique, Paris, France, has also been appointed a research associate. His work will be supported by the Air Research and Development Command. **Gregor Wentzel,** a professor at the University of Chicago, will become a part-time visiting professor of theoretical physics.

**Robert R. Harry,** Assistant Curator of Fishes in the Academy of Natural Sciences, Philadelphia, is participating in the coral atoll project in the Pacific for the second year. His participation is made possible by George Vanderbilt, who is a sponsor of the development of a fish study center in the Academy. Dr. Harry is one of the group of scientists representing the Office of Naval Research, National Research Council, Pacific Science Board, United States National Museum, and Harvard, Yale, and Stanford universities, that is studying the natural history and peoples among the trust islands taken over by the United States after World War II. This will be the project's fourth year.

**C. B. Hunt,** formerly Chief of the General Geology Section at the U.S. Geological Survey headquarters in Denver, has been appointed Executive Director of the American Geological Institute, Washington, D.C. He succeeds **Robert W. Webb,** who is returning to his post as Chairman of the Department of Geology at Santa Barbara College.

**Arthur W. Lindquist,** an entomologist in the U.S. Department of Agriculture since 1931, has been named Head of the Division of Insects Affecting Man and Animals. He succeeds Edward F. Knipling (News and Notes, July 17). Dr. Lindquist is a pioneer in

research to apply techniques of atomic science to entomological investigations.

**Edmund H. MacLaughlin,** Associate Professor of Biology and Pharmacognosy at the Philadelphia College of Pharmacy and Science and a member of its teaching staff since 1927, has been named Research Associate in the Pharmacy Section of Sharp & Dohme.

**Earl B. Millard,** Professor of Chemistry and Secretary of the Faculty at the Massachusetts Institute of Technology, has retired. Prof. Millard's association with M.I.T. began with his appointment as Instructor of Inorganic Chemistry in 1914. He became Professor in 1929, and from 1922–1935 he served in addition as Assistant Director of the Institute's Division of Industrial Cooperation.

Prof. Millard is a graduate of the University of Colorado. He holds an M.S. from the University of Wisconsin, and a Ph.D. from the University of Illinois. During World War I he participated in research which was in part responsible for the development of the gas mask. He held a number of administrative posts in connection with World War II activities at M.I.T., and was engaged in work with the Chemical Warfare Development Laboratory. Dr. Millard is an authority on textile and soap chemistry. His book on *Physical Chemistry for College Students,* first published in 1921, is now in its seventh revision and is still widely used in colleges throughout the country.

**Luigi Z. Pollara,** a professor at Siena College, has been appointed Associate Professor in the Department of Mathematics, Stevens Institute of Technology.

**A. L. Putnam,** Associate Professor of Mathematics, has succeeded **E. P. Northrop,** Professor of Mathematics, as Chairman of the Mathematics Staff in the College of the University of Chicago.

**R. D. Schafer,** an assistant professor in the University of Pennsylvania, has been appointed Professor of Mathematics and Head of the Department at the University of Connecticut.

**Henry Scheffé,** an associate professor in the Department of Mathematical Statistics at Columbia University, has been appointed Professor of Mathematics and Assistant Director of the Statistical Laboratory of the University of California, Berkeley.

**O. H. Smith,** Professor Emeritus of Physics at DePauw University, has been named the 1953–54 Hill Foundation guest professor at Hamline University and Macalester College, both in St. Paul, Minn. In 1952 the Louis W. and Maud Hill Foundation established a three-year series of guest professorships at five Minnesota institutions.

**Walton R. Smith** has been made Chief of the Forest Utilization Service at the Southeastern Forest Experiment Station, Asheville, N.C. Mr. Smith has served the U.S. Forest Service for 18 years. His new position involves representing the Forest Products Laboratory in contacts with wood-using industries from Virginia to Florida.

**Allen H. Spinner,** who has been Visiting Assistant Professor of Industrial Engineering at Stevens Institute of Technology, will join the permanent faculty as Associate Professor.

Two research chemists of the Corning Glass Works, **S. Donald Stookey** and **Robert H. Dalton,** are to be awarded John Price Wetherill Medals by the Franklin Institute of the State of Pennsylvania for their discovery of a revolutionary photosensitive glass process.

## Education

The Council on Dental Education of the **American Dental Association,** Chicago, has issued a list of accredited schools for dental hygienists. A total of 21 schools is included. In this first nation-wide evaluation of education for dental hygienists, the Council gave full approval to training courses at 18 universities and provisional approval to the curricula of three schools. A minimum of two years of college study is required for a certificate in the field, and advanced study for a degree is provided for students intending to serve in dental clinics, school systems, and the like.

**Baldwin-Wallace College,** Berea, Ohio, has joined with **Illinois Institute of Technology** in offering a combined educational program in liberal arts and engineering. Under the program, students earn degrees in both liberal arts and engineering simultaneously. Addition of the combined program at Baldwin-Wallace brings to 18 the number of schools participating with Illinois Tech in this educational plan. The program operates as follows: Students attend Baldwin-Wallace, or one of the other cooperating schools, for three years, then spend two years at I.I.T. Upon completion of the five-year program, they receive a B.A. degree from their former school and a B.S. degree in some field of engineering from Illinois Tech.

**Ohio State University** is planning to expand its teaching and research program in the field of aviation medicine in the near future, and it is anticipated that residencies will be available in this field within the current academic year.

A new **school of nursing** to provide basic nursing training in two years is to be opened in September at the Maisonneuve Hospital, Montreal, with financial assistance from the Canadian government. The new school will be an experiment with a threefold objective: (1) to improve clinical instruction of student nurses by ensuring more adequate supervision; (2) to improve courses of study, with emphasis on a better understanding of human nature and the role of the nurse as the doctor's assistant; and (3) to improve

means of developing a greater sense of responsibility among nurses.

Several experiments in nursing education have been carried out or are under way in Canada at the present time in an effort to increase the supply of nurses.

During the past three years the **University of Kansas** has greatly expanded its research activities and facilities for the training of graduate students in fields related to atomic energy. In this expansion, it has benefited from the generous cooperation of the United States Atomic Energy Commission.

Construction of the Radioisotopes Building was completed in July, 1952, and two projects dealing with various aspects of the biological effects of radiation, which had been under way elsewhere on the campus, were immediately transferred to the new building. The latter, which is now occupied almost to its entire capacity, is used for the reception and dilution of isotope shipments, preparation of active compounds for use in research, and housing of experimental animals for biological studies involving the use of radioactive substances. In addition, it provides space at present for five research projects, involving participation by four departments of the University.

A University Committee on Radioactive Substances is charged with supervision of the operation of the Radioisotopes Building, as well as with all responsibilities concerning the use of highly radioactive materials. This committee does not attempt to exercise any sort of censorship or even undertake any evaluation of the projected scientific problems, but rather, it deals with all matters relating to safety, health, space, and equipment in the new building. Its main purpose is to promote interest in radioactive substances and encourage and facilitate their application in research. The personnel of this committee includes the Director of the University Health Service, three members of the Department of Chemistry, two members of the Department of Physics, and one member each of the Departments of Anatomy, Chemical Engineering, and Zoology.

## Grants and Fellowships

The **American Heart Association** and its affiliates recently announced the awarding of Career Investigatorships to two faculty members of the Harvard Medical School, Boston. They are John R. Pappenheimer, newly named Visiting Professor of Physiology, and Albert H. Coons, Visiting Professor of Bacteriology and Immunology.

Dr. Pappenheimer, has centered his studies on the way in which the blood supplies the tissues. Dr. Coons has been working in the field of disease immunity. Both will continue their investigations at the Harvard Medical School under the American Heart Association appointment.

The Career Investigatorship was created by the Association to encourage unrestricted, lifetime medical research. The latest awards bring to three the number of Career Investigators being supported by the American Heart Association and its affiliates throughout their productive careers. Victor Lorber, the Association's first Career Investigator, named in 1951, is now conducting studies of chemical processes within the heart muscle at the University of Minnesota.

**The National Science Foundation** has announced 34 awards totaling about $208,000 for research in the biological and the physical sciences, and to support studies and conferences on science, scientific information exchange, compilation of scientific personnel information, and travel of American scientists to international scientific meetings.

This is the final group of awards to be made during fiscal year 1953 by the Foundation for the support of basic research and related matters. During the year, the Foundation made 292 awards totaling more than $2,151,000 in support of scientific activities. Since the beginning of the program in 1950, over 400 such awards have been made, totaling about $3,635,000. Additional proposals are being evaluated by the staff of the Foundation with the help of advisory panels of outstanding American scientists. A list of the grants follows:

University of North Dakota. Principal scientist, R. G. Severson, Dept. of Chemistry. Preparation and properties of certain substituted organosilanes, 1 year, $3,300.

Ohio Department of Natural Resources. Principal scientist, G. N. Cady, Division of Geological Survey. Petrographic constitution of Ohio coals, 2 years, $24,000.

Catholic University of America. Principal scientist, M. Gusinde, Department of Anthropology. Demography and physiology of South African Bushmen, 1 year, $4,500.

University of Pennsylvania. Principal scientist, J. R. Preer, Jr., Department of Zoology. Genetic cytoplasmic factors in paramecium, 1 year, $4,600.

Harvard University. Principal scientist, F. H. Westheimer, Department of Chemistry. Chemical models of enzyme systems, 15 months, $6,000.

Yale University. Principal scientist, G. E. Hutchinson, Department of Zoology. Amino acids in lake waters, organisms and sediments, 1 year, $1,000.

University of Maryland. Principal scientist, M. J. Pelczar, Department of Bacteriology. The microbiological degradation of lignin, 1 year, $5,000.

Vanderbilt University. Principal scientist, F. R. Blood, Department of Biochemistry. Biochemistry and nutrition of the bat, 2 years, $9,500.

Biological Abstracts, Inc. Emergency support of *Biological Abstracts*, 2 years, $25,000.

Columbia University. Principal scientist, E. J. Simmons, Department of Slavic Languages. Translation of scientific papers from the Russian and compilation of a Russian-English scientific glossary, 1 year, $40,000.

Smithsonian Institution. Program for foreign exchange of scientific, literary, and governmental reports, 6 months, $6,000.

American Council of Learned Societies. Principal scientist, J. F. Wellemeyer, Director, ACLS National Registration Program. For publication of the combined coding and classification systems used in its national registration

of the American Council of Learned Societies, 3 months, $800.

American Mathematical Society. Principal scientist, E. G. Begle, Secretary. Survey to determine operating procedures to be followed in compilation and maintenance of a register of mathematicians, 3 months, $650.

American Veterinary Medical Association. Principal scientist, J. G. Hardenbaugh, Executive Secretary. To establish a register of veterinarians, 3 months, $2,600.

Federation of American Societies for Experimental Biology. Principal scientist, Milton O. Lee, Federation Secretary. To establish a register of experimental biologists, 1 year, $11,400.

National Academy of Sciences. Principal scientist, Robert W. Webb, Executive Director, American Geological Institute. To establish a register of scientific and technical personnel in the earth sciences, 1 year, $11,500.

Walter H. Hodge, Silver Spring, Md. For publication of results of basic research entitled "Flora of Dominica, B. W. I.," 1 year, $1,700.

*Studies in Science*

Amherst College. Conference on physics research in colleges, $4,200.

Columbia University. Symposium on the biochemical and physiological interrelationships of glutathione, $8,200.

Duke University. Conference on cosmic rays, $8,500.

Lowell Observatory. Colloquium of astronomers, $5,000.

National Academy of Sciences. Support of Committee on Photobiology, $10,000.

University of Rochester. Fourth Annual Conference on High Energy Nuclear Physics, $3,000.

University of Wisconsin. Symposium on utilization of solar energy, $6,000.

*Attendance at International Meetings*

Thirteenth International Congress of Pure and Applied Chemistry, $1,000. Supported: M. L. Wolfrom, Department of Chemistry, Ohio State University, and J. T. Edsall, University Laboratory of Physical Chemistry, Harvard University.

Fourteenth International Congress of Zoology. $1,100. Supported: R. L. Usinger, Department of Entomology and Parasitology, University of California, and G. W. Sinclair, Department of Geology and Geography, Ohio Wesleyan University.

Colloquium on Cosmic Rays, Commission on Cosmic Rays of the International Union of Pure and Applied Physics. $560. Supported: G. T. Reynolds, Palmer Physical Laboratory, Princeton University.

Sixth International Congress for Microbiology. $2,500. Supported: J. P. Fox, Department of Tropical Medicine and Public Health, Tulane University; S. E. Branham, National Microbiological Institute, National Institutes of Health; O. N. Allen, Department of Bacteriology, School of Agriculture, University of Wisconsin; R. Sager, Department of Biochemistry, Rockefeller Institute for Medical Research; and W. Szybalski, The Biological Laboratory, Long Island Biological Association.

On behalf of the **James Picker Foundation,** the National Research Council announces the continued availability of funds in support of radiological research. Applications are reviewed and funds are administered by the Committee on Radiology of the Council's Division of Medical Sciences. Final determination of awards is made by the Foundation upon recommendation of the Committee. The foundation has expressed particular interest in the support of studies oriented toward the diagnostic aspects of radiology. Awards are not restricted to citizens of the United States.

Grants-in-aid are designed to encourage research offering promise of improvement in radiological methods and diagnosis or treatment of disease. *Applications for grants-in-aid for the fiscal year 1954–1955 must be submitted on or before 30 November 1953.*

Grants for scholars are a transitional form of support, designed to bridge the gap between the completion of fellowship training and the period when the young scientist has thoroughly demonstrated his competence as an independent investigator. A grant of $6,000 per year will be made directly to the scholar's institution as a contribution toward his support, or his research, or both. Initial grants are limited to one year, but renewal may be recommended. *Applications for 1954–1955 should be submitted by the institution on behalf of the candidate prior to 31 December 1953.*

Fellowships in radiological research available under the program of the Foundation, have been announced separately. Further details and application blanks may be obtained from the Division of Medical Sciences, National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D.C.

## Meetings and Elections

**The American Dairy Science Association** has elected the following officers for the year 1953–54: pres., W. V. Price, University of Wisconsin; v. pres., L. A. Moore, Bureau of Dairy Industry, Washington, D. C.; sec.-treas., P. R. Ellsworth, Ohio State University.

The **Atlantic Estuarine Research Society** has elected the following officers for 1953–54: pres., James B. Engle, Chief, Chesapeake Shellfish Investigations, U.S. Fish and Wildlife Service, Annapolis, Md.; sec.-treas., David G. Cargo, Maryland Dept. of Research and Education, Solomons, Md.

The **Corn Belt Branch** of the **American Society of Agronomy** has elected the following officers for 1953–54: chairman, E. F. Frolik, University of Nebraska; sec.-treas., M. O. Pence, Purdue University.

Leading cardiologists, industrialists, and labor, insurance, and government representatives will participate in a conference devoted to the medical and socio-economic problems of the cardiac person in American industry. The one-day meeting, called the **Heart-in-Industry Conference,** will be held Nov. 20 at the Hotel Statler in New York City. It is being sponsored by the N.Y. Heart Association. Norman Plummer, Medical Director of the N.Y. Telephone Co. and chairman of the Cardiovascular Diseases In Industry Committee of the New York Heart Association, has been appointed chairman of the Conference Steering Committee.

An **International Symposium on the Dynamics of Virus Infection** will be held at the Henry Ford Hospi-

tal, Detroit, on Oct. 21, 22, and 23. Moderators for the various sessions are: Thomas M. Rivers, The Hospital of the Rockefeller Institute for Medical Research; John G. Kidd, Cornell University Medical College; Albert E. Sabin, The Children's Hospital Research Foundation, Dept. of Pediatrics, University of Cincinnati; John Paul, Yale University School of Medicine; A. J. Rhodes, The Hospital for Sick Children, Toronto, Canada; and Gilbert Dalldorf, Division of Laboratories and Research, N.Y. State Dept. of Health, Albany.

In addition to specialists in virus research from all over the United States, the following distinguished visitors from abroad will participate: Alfred Gottschalk, The Walter and Eliza Hall Institute of Medical Research, Royal Melbourne Hospital, Melbourne, Australia; Preben von Magnus, State Serum Institute, Copenhagen, Denmark; F. C. Bawden, Rothamsted Experimental Station, Harpenden, Herts, England; J. Ralph Audy, Scrub Typhus Research Unit, Institute for Medical Research, Kuala Lumpur, Malaya; A. W. Downie, University of Liverpool, School of Hygiene, Liverpool, England; and F. O. MacCallum, Central Public Health Laboratory, London, England.

The **Kansas Academy of Sciences** has elected the following officers for 1953–54: pres., R. E. Mohler, Prof. of Biology, McPherson College; pres.-elect, A. C. Carpenter, Pres., Lesh Oil Co., Ottawa; v. pres., D. J. Rogerson, Asst. Prof. of Botany, Kansas State College, Manhatten; treas., Standlee Dalton, Registrar, Fort Hays Kansas State College, Hays. A. M. Guhl, Dept. of Zoology, Kansas State College, is representative to the AAAS Council.

The fourth annual **National Noise Abatement Symposium** is to be held Oct. 23–24 at the Armour Research Foundation of the Illinois Institute of Technology, Chicago. The symposium, designed to give a comprehensive picture of nation-wide activities in the field of noise, will feature talks by leading authorities on outdoor noise problems. One session will be devoted to the industrial noise hazard.

More than 300 scientists, engineers, doctors, architects, manufacturers, and civic authorities are expected to attend. Although the previous meetings have been one-day affairs, this year's symposium has a broader scope and will extend over a two-day period. Eleven speakers will fill out the agenda for the three sessions that have been scheduled.

A **symposium on population genetics,** under the auspices of the International Union of Biological Sciences, was held in Pavia, Italy, Aug. 20–22, with Professor A. Buzzati-Traverso as chairman. The contributed papers and discussions emphasized the effects of selection on the genetic structure of natural and artificial populations, as well as the mechanisms that help to integrate the genetic contents of a population into a co-adapted system.

Original papers were contributed by Scossiroli (Pavia), A. Robertson (Edinburgh), Wallace (Cold Spring Harbor), Falconer (Edinburgh), and H. Lewis (Los Angeles). Among the leaders of the discussion were Buzzati, Dobzhansky, Epling, and Haldane, as well as R. A. Fisher, Ford, Mather, Mayr, J. Clausen, Lerner, and others. Original papers and discussions of this symposium, which marks an important step in the development of new concepts in the field of population genetics, will be published shortly. Orders are to be placed with Professor Magni, Istituto di Genetica, Piazza Botta, Pavia, Italy.

The **University of Tennessee,** Knoxville, will observe the fortieth anniversary of its Department of Bacteriology with a symposium on Oct. 16. Speakers include C. E. Brehm, President of the University, Alexander Hollaender of the Oak Ridge National Laboratories, Frederick W. Fabian of Michigan State College, Francis B. Gordon of the Chemical Corps Biological Laboratories, Frederick C. Fink of Chas. Pfizer & Co., Inc., Oram C. Woolpert of the Ohio State University Research Foundation, and D. Frank Holtman of the University of Tennessee. All interested scientists are cordially invited to attend.

## Miscellaneous

Two advisory committees to the U.S. **Atomic Energy Commission,** the Reactor Safeguard Committee and the Industrial Committee on Reactor Location Problems, have been combined to form a new group known as the **Advisory Committee on Reactor Safeguards.** The two committees were combined because the initial objectives of the Industrial Committee on Reactor Location Problems have been fulfilled, and the responsibilities of the committees were becoming closely associated. The new committee will have the following functions:

1. Reviewing hazards summary reports prepared by organizations planning to build or operate reactor facilities, including criticality experiments.

2. Advising the AEC regarding the consistency of proposed reactor locations with accepted industrial safety standards, taking into account the proposed exclusion areas for reactors and the proximity of surrounding population and property.

The following is a resolution recently adopted by the Council of the Institute of Mathematical Statistics regarding **Mina Rees.**

Dr. Mina Rees has resigned from her position as Chief of the Division of Mathematical Sciences of the Office of Naval Research, effective September, 1953, and assumes the position of the Dean of the Faculty at Hunter College, New York City. The Council of the Institute of Mathematical Statistics feels that her departure from the Office of Naval Research should not pass unmarked.

During the last war it became apparent that the state of science and technology of a country is a paramount factor in its survival. Hence, the end of World War II was followed by an epoch of peace-time Federal support of science, first through the activities of the Office of Naval Research, then through the activities of similar organizations in the two other armed services and, finally, through the birth and development of the National Science

Foundation. Thus, the Office of Naval Research did the pioneer work in Federal support of science.

Naturally, the armed services are most obviously interested in military research, hence in applied research. The Office of Naval Research has showed by example that it understood that, to be effective, applied research must be preceded by fundamental research. In order to have appropriate scientific personnel in case of war and in order to obtain without great delay the solutions of the various military-scientific problems arising from a war, it is necessary to train personnel in advance and to build a reservoir of new scientific results and new methods.

Under Dr. Rees' leadership the Division of Mathematical Sciences of the Office of Naval Research gave wholehearted support to basic research, in particular to basic research in mathematical statistics and probability. The whole action was conducted with remarkable foresight and wisdom. Basic research has always meant basic research, unhampered by possible demands that it be of immediate usefulness to the Navy. As a result, the long-range interests of the Navy and of the whole Nation were effectively served. The fruits of this activity have already been many and important and will continue to appear for many years to come.

The great demand for trained mathematical statisticians existed before and during the war, and still persists. As noted by the Committee of the National Research Council in the 1940's, there were at the time only a very few centers of instruction capable of training Ph.D.'s in mathematical statistics. Now the number of such centers has increased substantially. The Office of Naval Research basic research projects in these centers employ a great number of young men who thus obtain the training necessary for research and teaching.

The postwar development of mathematical statistics in the United States owes a great deal to the farsighted policy of the Office of Naval Research ably administered by Dr. Rees. Mathematical statistics owes Mina Rees a public "well done," and extends its best wishes to her successor at the Office of Naval Research.

**Recent visitors** at the National Bureau of Standards:

Sir David Brunt, who visited the National Bureau of Standards in his capacity as Chairman of the Research Council Electricity Authority. He is also Secretary of the Royal Society, London, England.

J. E. Fullard, Technical Officer, South African Bureau of Standards, Pretoria, South Africa.

Naonobu Shimomura, Chief Radio Engineer, Tokyo Shibaura Electric Company, Kawasaki, Japan.

M. L. Ghai, Assistant Director, National Physical Laboratory of India, New Delhi, India.

Koji Sato, Professor at Tokyo University, Tokyo, Japan.

R. Bouressa, Ministry of Health of the Province of Quebec, Montreal, Quebec.

Roberto Reyna, Civil Engineer, Panama City, Panama.

Antonio J. Suere, Civil Engineer, Panama City, Panama.

## Recent Deaths

**Lawrence I. Barbier** (47), electronics engineer, Takoma Park, Md., Aug. 16; **John H. Bateman** (61), professor of civil engineering, Baton Rouge, La., Aug. 23; **Wendell C. Bennett** (47), anthropologist and author, Martha's Vineyard, Mass., Sept. 6; **Frank G. Crandall, Jr.** (57), allergist, Los Angeles, Calif., Aug. 25; **Henry Ditenfass** (68), otolaryngologist, professor and author, Philadelphia, Pa., Aug. 25; **Kenneth H. Donaldson** (?), metallurgical engineer and professor, Cleveland, Ohio, Sept. 3; **Frank R. Ferlaino** (53), specialist in industrial medicine, Brooklyn, N.Y., Sept. 2; **Fred Gibson** (60), botanist, Superior, Ariz., Aug. 24; **Arthur K. Gilkey** (26), geologist, Mount Godwin Austen, Kashmir, Pakistan, Aug. 10; **Arthur M. Greene, Jr.** (81), Dean Emeritus of Princeton University's School of Engineering, Princeton, N.J., Sept. 2.

**James G. Hardy** (79), professor of mathematics, Portland, Ore., Sept. 5; **Samuel C. Harvey** (67), oncologist and professor, New Haven, Conn., Aug. 23; **Bradford K. Hawes III** (36), physicist, Bethesda, Md., Sept. 3; **Rudolph O. A. Hober** (79), physiologist, biological chemist and author, Philadelphia, Pa., Sept. 5; **Ernest E. Howard** (72), civil engineer and author, Kansas City, Mo., Aug. 19; **Elliott H. Hutchins** (73), surgeon and professor, Baltimore, Md., Aug. 24; **John C. Kaudy** (30), research chemist, Los Angeles, Calif., Sept. 1; **Stephen London** (67), internist and professor, New York, N.Y., Aug. 23; **Harris F. MacNeish**, professor of engineering mathematics, Miami, Fla., Aug. 28; **Richard O. Marsh** (70), civil engineer, explorer and author, Vero Beach, Fla., Sept. 4; **Henry E. Moskey** (61), veterinary medical director of the Food and Drug Administration, Arlington, Va., Aug. 24; **Emerson A. North** (73), psychiatrist and professor, Daytona Beach, Fla., Aug. 21.

**John J. O'Neill** (64), science editor and author, Freeport, L.I., N.Y., Aug. 30; **Roland G. Porter** (59), professor of electrical engineering, Beverly, Mass., Sept. 2; **Ludwig Prandtl** (78), aerodynamics expert, Göttingen, Germany, Aug. 19; **Lawrence Radford** (65), optical engineer, Washington, D.C., Aug. 19; **René Sand** (76), leader in international medical groups and author, Brussels, Belgium, Aug. 23; **Nathan Savitsky** (50), neuropsychiatrist, New York, N.Y., Sept. 4; **Eben T. Takamine** (63), president of Takamine Laboratory, Ridgewood, N.J., Aug. 28; **Lee M. Thurston** (58), U.S. Commissioner of Education, Washington, D.C., Sept. 4; **Alfred H. White** (80), professor emeritus of chemical engineering, Ann Arbor, Mich., Aug. 25; **William J. Withrow** (46), professor of chemistry, New York, N.Y., Sept. 4; **Frederick E. Wright** (75), geophysicist, Gananoque, Canada, Aug. 25.

# Technical Papers

## The Roles of Darkness and Light in the Activation of Avian Gonads[1]

Donald S. Farner, L. R. Mewaldt, and Stanley D. Irving

*Laboratories of Zoophysiology, Department of Zoology, State College of Washington, Pullman*

Recently Kirkpatrick and Leopold (*1*) have shown with quail (*Colinus virginianus*) that interruption of the dark period results in photoperiodic gonadal response not obtainable with a continuous dark period and the same amount of photoperiod. They conclude that the dark period is an inhibiting factor in this species, and suggest that the duration of the dark period is a major controlling factor in photoperiodic responses. Jenner and Engels (*2*) have obtained similar results with male finches and conclude that there is a critically important *dark-dependent phase* in avian photoperiodism, although rapid testicular development has been obtained (*3, 4*) by treatment with continuous light.

We have recently completed a pertinent series of experiments on the photoperiodic responses of white-crowned sparrows (*Zonotrichia leucophrys gambelii*), the details of which are summarized in Tables 1 and 2. The light treatments (30–40 ft-c) were applied for 29–30 days, beginning on February 14. Differences between all possible pairs of arithmetic means are significant ($P = 0.01$) except those of B-D, C-E, C-F, and E-F; however, C-E and E-F are significant at the 5% level. Analyses of logarithms of testicular weights indicate that the differences between all possible pairs of geometric means except C-F are significant ($P = 0.01$).

These results suggest the possibility that the light-stimulated gonadotropic mechanism, which doubtless involves the anterior pituitary and hypothalamus (*5*), is of such nature that it becomes active almost immediately after the beginning of the photoperiod and has a persistent carry-over period of activity after the end of the photoperiod. We envision the effective duration of the carry-over period to be of the order of a fraction of an hour to several hours and probably a function of the duration and nature of the preceding photoperiod, its characteristics varying also according to species. The rate of testicular response would then be a direct function of the summated daily gonadotropic effects of the photoperiods and carry-over periods. Several possible physiologic bases for such a carry-over period will be discussed in a subsequent and more detailed paper.

This hypothesis accounts for the difference between groups A and D as the effect of the additional carry-over period in D. The treatment and responses in group D were similar to those described by Jenner and Engels (*2*). The differences between D and E could be attributed to the greater number of carry-over periods in E. The differences between E and F could be the result of greater activity in carry-over periods which follow 1-hr photoperiods than in those which follow 1-min photoperiods. The inverse relation between the length of the longest dark period and the response in quail (*1*) might be explained as the attainment of maximum effects of two carry-over periods by optimum spacing. This hypothesis also apparently rationalizes similar results obtained in treatment of ducks (*6*) and starlings (*7*) with interrupted light. It may be applicable to the light-stimulated increase in egg production of the domestic fowl, since it has been shown (*8–10*) that fractionation of the photoperiod increases the response. However, the available information (*11–13*) suggests that this hypothesis should not be extended to photoperiodism in mammals.

In most, if not all, avian species which show marked gonadal photoperiodism, there develops, following a

[1] Supported by funds provided for medical and biological research by the State of Washington Initiative Measure No. 171.

TABLE 1

LIGHT TREATMENTS

| Group | Daily Exposure to Light | | | | | Total Hours |
|---|---|---|---|---|---|---|
| | 4 | 8 | Noon | 16 | 20 | |
| A | | ——— | ——— | ——— | | 10 |
| B[1] | | ——— | ——— | ——— | | 12.2[1] |
| C | | ——— | ——— | ——— | ——— | 18 |
| D | ——— | | ——— | ——— | ——— | 10 |
| E[2] | ····· | | ——— | ——— | ····· | 10 |
| F[3] | — — — | — — — | — — — | — — — | — — — | 10 |

[1] Wild controls; mean Feb. 14–Mar. 16, including civil twilight.

[2] Continuous light 0710–1650 plus 1 min each half-hour from 0300 to 0700 and from 1700 to 2100.

[3] Nine 1.11-hr light periods separated by eight 1-hr periods of darkness (0300–2100).

TABLE 2

TESTICULAR WEIGHTS

| Group | Number | Arithmetic mean, mg | Geometric* mean, mg | Range, mg |
|---|---|---|---|---|
| A | 8 | 1.2 | 1.2 | 0.6–1.6 |
| B | 12 | 3.9 | 3.8 | 3.0–6.0 |
| C | 7 | 190 | 170 | 79–250 |
| D | 10 | 8.2 | 6.8 | 3.0–25 |
| E | 15 | 87 | 65 | 17–210 |
| F | 13 | 170 | 140 | 35–310 |

* Obtained by logarithmic transformation of testicular weights.

cycle of gonadal activity, a refractory period during which an increase in daily photoperiod does not evoke gonadal development. Apparently short daily photoperiods, or long dark periods, are necessary to terminate this refractory period (*14, 15*). However, once the refractory period has ended, our hypothesis suggests, apparently contrary to those cited above (*1, 2*), that the daily dark period per se has no positive function, although the effect of a carry-over period may be exerted during the dark period. Possibly the differences are semantic; we feel, however, that our hypothesis is basically different and represents a more logical rationalization of the available data. Like Hammond (*13*), we feel that the assignment of an active role to the dark period is an unnecessary assumption; however, our alternative hypothesis is somewhat different.

Although analogies (*1, 2*) with photoperiodisms of plants, in which there are essential dark-dependent reactions (*16*), are attractive, extreme caution must be exercised since it is quite possible that the effect of darkness in the avian photoperiodic mechanism may be only that of cessation of a process, or processes, requiring light. Our hypothesis is proposed as one possible rationalization of the available information on the mechanism of avian photoperiodism. We feel that its tentative acceptance is favored by the Law of Parsimony as the simplest apparent rationalization.

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Manuscript received April 9, 1953.

## A Simplified Method for Measuring Emotional Defecation in the Rat


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Hall's (*1*) unwieldy open field test has been established as the yardstick for measuring the intensity of emotionality in the rat (*2, 3*). Some important observations on the defecation of rats in simpler situations seem to have been overlooked. For example, it had been established that the defecation of rats placed in a strange enclosure decreased from trial to trial, until practically all defecation ceased (*4, 5*). This factor, in conjunction with other investigations, led Hall to the realization that defecation was an index of emotionality in all unfamiliar situations.

It seemed to the present writer that if strangeness were the decisive factor in producing emotional defecation, then, Hall's open field test was not necessary to determine emotionality. Any simple unfamiliar situation should do as well. A review of the literature and correspondence with C. S. Hall indicated that no investigator seems to have related a simple, strange situation with the open field.

The present report discloses a procedure whereby savings in laboratory space, money, and time may be made by substituting a simple, strange situation for the 8 ft of apparatus needed for the open field test.

Ten adult male rats were used as subjects. Each was randomly introduced into one of three situations. Following this, a regular sequence was observed. If a rat was placed in the open field first, for example, he would next be placed in a familiar situation. The familiar situation consisted of a standard $7 \times 7 \times 10$ cage placed on top of the rat's community cage. Following exposure here the rat would then be placed in the simple, unfamiliar situation. This situation was another standard cage placed in an unfamiliar room—a laboratory storage room in which no rats had been kept.

Each rat had one 5-min trial a day for 10 days in each of the 3 situations. The field and cages were cleaned immediately after any trial in which urination or defecation occurred.

The statistical sign test (*6*) was employed to compare emotional defecation in the 3 situations. In comparing emotional defecation in the open field test and in the familiar situation, the sign test was significant at the 1% level of confidence. In comparing emotional defecation in the strange situation and in the familiar situation, the sign test was significant at the 5% level of confidence. Such levels of confidence indicated that emotional defecation in both the open field test and the strange situation was significantly different from emotional defecation in the familiar situation. No differences in emotional defecation were found in a sign test comparison of defecation in the open field and in the strange situation.

These findings suggest that a clean, relatively odorfree, standard rat cage, placed in a strange situation, will elicit emotional defecation in a manner similar to that of Hall's open field test. If such is the case the open field test does not need to be used to measure emotionality in rats. The rather large amount of space the open field requires, the expense involved in purchasing material with which to build it, and the time taken to construct it, can all be put to other uses in the laboratory. A clean standard cage placed in an unfamiliar room should do as well.

This technique has value in several important areas of inquiry in the field of emotionality. The fact that far less floor space is taken up by a standard rat cage than by Hall's 8 ft of apparatus makes it possible to house more rats in the laboratory. This consideration is of importance in studying the inheritance of differences in emotion. When many selectively bred filial generations of rats are required, laboratory space will be at a premium. The strange situation test of emotionality demands little space. Also, in investigating the intercorrelations between emotionality and other responses such as fighting, delay in starting in a runway, and running in an activity wheel, it is customary to determine the emotionality of one rat at a time in the open field. Most laboratories can give space to only one open field test. However, by placing many standard cages in strange situations the emotional defecation of several rats may be simultaneously determined. This will result in a substantial saving in the experimenter's time. A large number of the most emotional rats and the least emotional rats can be selected in a matter of days instead of weeks.


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Manuscript received June 15, 1953.


## Stimulation of the Reticuloendothelial System with Choline[1]


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The reticuloendothelial system (RES) has several vital known roles and probably has several other still unknown functions. Among the known actions of the RES is its role in the production of antibodies, phagocytosis of negatively charged colloids, effect on intermediary metabolism of some lipids, and protective action against radiation effect.

Various methods including whole body radiation (*1*) and cortisone (*2*) have been shown to depress the RES. However, because of the vital functions of the RES, the development of a factor which can excite this system to hyperfunction was considered most important. With the exception of various so-called anti-reticulocytotoxic sera, whose action still remains in doubt, and histamine, no practical means has been at hand to stimulate the RES. The requirements of such an activator include lack of toxicity as well as side effects. These criteria exclude vital dyes such as trypan blue. Such substances induce a hyperfunctional state by first producing RES damage (*3*).

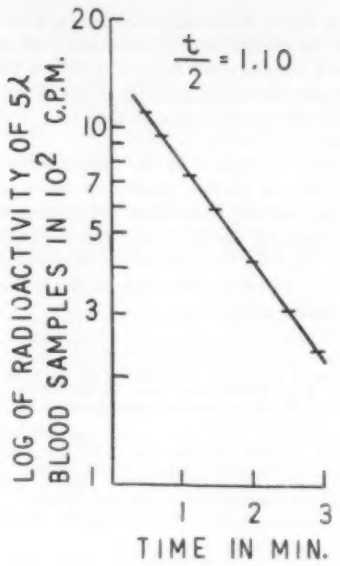


FIG. 1. Disappearance velocity of colloidal $CrP^{32}O_4$ from the circulation of a mouse. The $t/2$ value is the time wherein 50% of the radioactivity has left the vascular bed.

It had been pointed out in *in vitro* experiments by Chevremont (*4*) that of many substances tested, choline was the only compound that stimulated histiocyte formation in tissue culture. Later, Smulders (*5*) indicated that by injecting choline he could find an increased number of athrocytes in the liver in frogs by using histological techniques. As part of the search in this laboratory for a physiologic RES activator, choline was used to determine whether or not it activated the RES in mammals.

Both histologic and radioautographic studies in this laboratory (*6*) demonstrate that chromium phosphate is exclusively picked up by the RE cells. Using the rate of phagocytosis of negatively charged colloidal $CrP^{32}O_4$ as an indicator (*7–9*), experiments with intramuscularly injected choline were performed. It could be demonstrated that choline caused an RE hyperfunction of the order of 100% compared to saline injected controls.

Phagocytic velocity in each mouse was measured by plotting the radioactivity of each of 7 consecutively drawn 5 lambda blood samples against time (Fig. 1). As can be seen, the disappearance velocity is an exponential function. From this curve, the biological half-life ($t/2$) of the colloid in the vascular bed can be calculated. Hence, the $t/2$ value is that time wherein 50% of the $CrP^{32}O_4$ disappears from the blood.

Five series of 10 DBA, 90-day-old mice obtained from Rockland Farms were injected with 0.2 mg of


[1] Supported in part by a grant in aid from the Atomic Energy Commission, Project AT(30-1)1068, from Eli Lilly and Company.


[2] This work was done during the tenure of an established investigatorship of the American Heart Association.

choline in saline, twice daily for 3 days. The mean $t/2$ value of 50 choline-treated mice was 0.61 min compared with the mean $t/2$ value of 1.10 min for 30 control animals. Statistical analyses of the differences between the two groups showed that they were highly significant ($P < 0.01$).

The effect of choline on the regenerative capacity of the RES and further studies on other substances are now in progress. The ability to stimulate the phagocytic velocity of the RES indicates a probable activation of RE cells. To what extent phagocytic velocity is indicative of other functions of the RE cells still remains to be established.

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Manuscript received April 16, 1953.

## Increased Translocation of Plant-Growth-Modifying Substances Due to Application of Boron[1]


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Translocation of growth-modifying substances such as 2,4-dichlorophenoxyacetic acid (2,4-D) and its salts and esters from leaves to other parts of plants is associated with translocation of photosynthates (*1–4*). Gauch and Dugger (*5*) found that boron accelerated translocation of sucrose applied externally to leaves of bean and tomato plants. Stark and Matthews (*6*) increased the percentage of soluble solids (mostly sugars) of cantaloupe fruits by spraying the plants with a dilute solution of boric acid. Seemingly, this indicates that boron accelerated translocation of sugars to the fruits.

The present investigation was undertaken to determine if boron would accelerate translocation of growth-modifying substances from leaves to stems by affecting translocation of sugars.

In preliminary experiments in darkness, translocation of radioactively tagged 2,4-D ($C^{14}$ of COOH group) from the primary leaves to the stems of bean plants was greater when tips of treated leaves were immersed in an aqueous solution containing 50 ppm of boron and 10% sucrose than when they were immersed in a sugar solution without boron. An aqueous mixture containing 30 μg (γ) of 2,4-D and 0.1% Tween 20 was spread evenly on the upper surface of the proximal half of one primary leaf of each plant. The remaining half of the leaf was immersed in the solution containing boron (as boric acid) and sucrose. Leaves of control plants were treated with 2,4-D in the same way; some were immersed in a 10% sucrose solution and others in a solution containing 50 ppm of boron. Five plants were used for each type of treatment. After 48 hr the stems were dried, ground, and assayed for radioactivity with a flow counter (*7*). In successive experiments translocation of the 2,4-D was increased by approximately 43, 47, and 50% by boron in the sugar solution as compared with the sugar solution alone. Boron alone failed to affect translocation of the 2,4-D.

TABLE 1

EFFECT OF BORON (APPLIED AS BORIC ACID), SUCROSE, AND BORON PLUS SUGAR ON THE TRANSLOCATION OF 2,4-DNH, BY BEAN PLANTS*

| Treatment | Plant | | | | | | | | Av. |
|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | |
| 2,4-DNH (0.9 γ)$_4$ | 14 | 21 | 0 | 24 | 23 | 0 | 0 | 24 | 13.2 |
| 2,4-DNH + sucrose (0.9 γ)$_4$ (2000 γ) | 0 | 16 | 0 | 0 | 0 | 7 | 0 | | 3.3 |
| 2,4-DNH + sucrose + B (0.9 γ)$_4$ (2000 γ) (160 γ) | 38 | 37 | 45 | 33 | 52 | 44 | 29 | 29 | 44.7 |
| 2,4-DNH + B (0.9 γ)$_4$ (160 γ) | 47 | 26 | 32 | 11 | 27 | 22 | 34 | 27 | 28.2 |

* Figures represent degrees of stem curvature that developed during a 3-hr period immediately following treatment of 1 primary leaf on each plant.

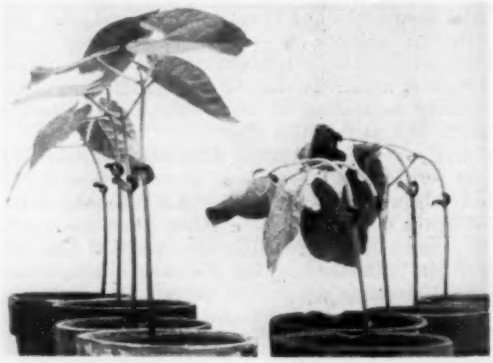

FIG. 1. Stem curvatures of bean plants due to application of 0.9 μg of 2,4-DNH$_4$, 2000 μg of sucrose, and 160 μg of boron to the right leaf of each plant (right row) compared with that induced by an equal amount of 2,4-DHN$_4$ and sugar. Photographed 3.5 hr after treatment.

[1] Scientific article No. A425. Contribution No. 2461. Maryland Agr. Expt. Station (Dept. of Botany). A cooperative study by the Bureau of Plant Industry, Soils, and Agricultural Engineering, and the University of Maryland.

TABLE 2

EFFECT OF BORON ON TRANSLOCATION OF VARIOUS GROWTH MODIFIERS FROM LEAVES TO STEMS OF BEAN PLANTS*

| Growth modifier | Amount of acid applied per leaf (γ) | Average curvature (degrees) | | Average increase in curvature (%) |
|---|---|---|---|---|
| | | Acid + sucrose | Acid + sucrose + boron | |
| 3-Indoleacetic acid | 0.5 | 2.8 | 34.2 | 1120 |
| 2,4,5-Trichlorophenoxyacetic acid | 0.9 | 8.0 | 36.5 | 356 |
| Alpha naphthaleneacetic acid | 2.0 | 13.4 | 28.8 | 115 |

* One-hundred-sixty micrograms of boron (as boric acid) plus 2000 μg of sucrose were applied together with the designated amounts of acid per leaf. Average curvature based on four replications.

In subsequent experiments boron, 2,4-D, and sugar, separately and in all combinations, were applied directly to the leaves of plants grown in composted soil in a greenhouse. Stem curvatures were used to indicate translocation of 2,4-D. Black Valentine bean plants were subjected during the test to light from Daylight fluorescent tubes (700 ft-c intensity). The primary leaves were 3–4 cm wide and the trifoliate leaves still folded in the terminal buds. The entire upper surface of one primary leaf of each plant (with a lanolin barrier at the distal pulvinus) was treated with 0.02 ml of an aqueous mixture containing ammonium 2,4-dichlorophenoxyacetate (2,4-$DNH_4$) and 0.1% of Tween 20. Eight plants were used for each type of treatment.

Nine-tenths microgram of the salt induced moderate stem curvature. Ten micrograms of boron together with 0.9 γ of 2,4-$DNH_4$ increased by approximately 50% the average curvature developed within 3 hr. Larger amounts of boron, including 160 γ per leaf, caused still greater increases in curvature.

Considerable variability in curvature resulted when 2,4-$DNH_4$ was used alone, probably due to variability in physiological activity of individual leaves (Table 1). Compared with 2,4-$DNH_4$ alone, 0.9 γ of the salt plus 2000 γ of sucrose reduced the average curvature 75%, apparently because of dilution of the 2,4-$DNH_4$ by the sugar. In contrast, addition of boron to the 2,4-$DNH_4$-sucrose mixture more than overcame this dilution effect by increasing stem curvature almost 14-fold (Fig. 1).[2] Even without externally applied sugar, boron accelerated translocation of 2,4-$DNH_4$ by 114% over that which resulted from the use of 2,4-D salt alone. This experiment was repeated twice and similar results were obtained each time but the magnitude of response varied.

Boron also accelerated the translocation of 3-indoleacetic, 2,4,5-trichlorophenoxyacetic, and alpha naphthaleneacetic acids from leaves to the stems of bean plants (Table 2).

Sucrose, fructose, and glucose plus 0.9 γ of 2,4-$DNH_4$ and 160 γ of boron were compared as external sugar sources. Two thousand micrograms of the sugar being tested were applied to each leaf. For comparison, leaves of comparable plants were treated with equal amounts of the sugar and 2,4-$DNH_4$ without boron. Boron with sucrose increased stem curvature by an average of 235, with fructose 427 and with glucose 1520% over that observed on plants not receiving boron.

It is concluded that the accelerating effect of boron observed in these experiments was directly upon movement of sugars and that translocation of growth modifiers was thus indirectly accelerated.

[2] When these experiments were repeated with both solutions adjusted to a pH of 5.4 (pH of the latter) a similar response was obtained.

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Manuscript received May 29, 1953.

## A Transplantable Rat Lymphoma


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A neoplasm arose spontaneously in the region of the submaxillary gland of a 1953 female breeder of the Lewis inbred strain of rats. The animal had already borne 3 litters; consequently, her offspring were available for transplantation of the tumor. Microscopical examination of the primary tumor and its metastases showed it to be a lymphoma.[2] Identification of the neoplastic cells by their mode of locomotion in tissue cultures (*1–3*) indicated that the majority of the cells were lymphoblasts, although large and small lymphocytes were also present.

Metastases were found in the mediastinal, axillary, inguinal, and lumbar lymph nodes of the host, and the spleen and thymus were greatly enlarged by growths of tumor cells. Macroscopical examination failed to

[1] Aided in part by a grant from the National Cancer Institute of the National Institutes of Health, Public Health Service, Bethesda, Md.

[2] We are indebted to Balduin Lucké, School of Medicine, University of Pennsylvania, for the identification of the tumor.

disclose metastases in the mesenteric and intestinal lymph nodes (Peyer's patches), or in the adrenals, kidneys, liver, lung, intestine, stomach, or thyroid of the host.

The lymphoma proved to be 100% transplantable during 8 passages in rats of the Lewis strain. The majority of rats were 50–70 days old. In rats of this age range, the subcutaneous transplants grew to a moderately large size (20 g) in about 3 wk. The rats developed paralysis of the hind quarters and died about 4 wk after implantation. The rate of growth of transplanted lymphomata was consistently more rapid in younger rats than in older ones.

Transplanted lymphomata are unlike sarcomata in appearance. They are flatter, much flabbier, and more translucent. They have a soft consistency throughout, are free from necrosis, and do not become encapsulated.

When this tumor was cut up in serum or balanced salt solution, many neoplastic cells became free and formed dense suspensions of the lymphocytic cells. Microscopical preparations of the area of tumor implantation showed that the neoplastic cells had disseminated into the surrounding tissue of the host. Multiplication and migration of these cells brought about a widespread local invasion which was considerably thicker in the central portion where the mass of implanted tumor was located. Continued multiplication and migration of the cells resulted later in the extensive flat tumors characteristic of this lymphoma.

In rats bearing transplanted lymphoma, metastases were found in the lymph nodes (with the exception of the mesenteric and Peyer's patches) and in thymus and spleen, but not in every one of these sites in every animal. Many rats bearing advanced lymphomata had metastatic growth in the thoracic intervertebral muscle, and in a few instances metastases were located in the roof of the cranial cavity and around the pituitary. Some rats exhibited malformations of the head which were indicative of intracranial metastases.

The presence of neoplastic cells in the blood stream was demonstrated by stained preparations and also by passage (intravenous, intraperitoneal, and subcutaneous) of blood from tumor-bearing rats into normal rats. Subcutaneous injections of 1–3 ml of whole blood drawn from the heart of a rat with advanced lymphoma resulted in the growth of typical lymphomas at the injection sites.

Subcutaneous implantations of the metastases located in various sites in lymphoma-bearing rats all gave rise to lymphomata similar to those arising from transplants of the primary neoplasm. The origin of implanted metastatic tissue did not influence the type of metastasis arising later in the host. For example, rats implanted with metastases located in the cranial cavity failed to develop an overlarge number of cranial metastases.

A few experiments were carried out in an effort to determine whether early ablation of transplanted lymphoma in rats would prevent the later development of metastases. Owing to the widespread dissemination of the neoplastic lymphoblasts during transplantation of the lymphoma, it was difficult to avoid recurrences when the tumors were excised by the usual surgical procedure.[3] However, when the lymphoma and a large area of the surrounding skin and subcutaneous tissue were first sewed off and then excised, as described by Lewis and Maxwell (*4*), recurrence was slight. Nevertheless, metastases developed in a number of the operated rats even when the tumor had been excised within 5–8 days after its transplantation. The failure of ablation of lymphomata to render the hosts resistant to later development of metastases is consistent with the finding of Lewis and Maxwell that excision of a sarcoma growing in a rat does not protect the host from the growth of a subsequent implantation of tumor tissue.

The rat lymphoma proved unsuitable for studies (*5–8*) in which occlusion of a tumor's blood supply causes it to be absorbed and enables the host to develop tumor resistance. In many instances, the rubber tourniquet used to obstruct the blood supply for the necessary 8–24 hr failed to enclose some of the scattered neoplastic cells. Although the tumors damaged by lack of adequate blood supply became absorbed within 1–2 wk, the scattered neoplastic cells not included within the tourniquet later multiplied and formed a lymphoma.

In studies of the influence of certain therapeutic agents on the growth of carcinomata and sarcomata in mice and rats, it has been found that the majority of these tumor-inhibitory agents, and especially dyes (*9, 10*), bring about atrophy of the thymus without commensurate loss of lymphoid tissue in the treated animals. Since the rat lymphoma metastasizes to the thymus as well as to the lymph nodes, it seemed worth while to study the influence of tumor-inhibitory agents on the thymus and lymph nodes of rats bearing this tumor. The results of these experiments, which will be published later in detail, indicate that oral administration of antitumor substances brings about atrophy of the thymus gland. Frequently, metastases occurred in the lymph nodes of rats in which the entire cortex of the thymus was lacking. The results suggest that the small thymic cells may be influenced by factors that fail to exert an equal effect on the lymphocytic cells in rats bearing transplanted lymphomata.

The addition of this transplantable lymphoma to the large group of primary and transplantable carcinomata, sarcomata, and hepatomata already available for cancer research may prove of value in studies concerning agents that influence the behavior of metastasizing neoplastic cells.

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Manuscript received June 24, 1953.

## A New Articular Facet in the Upper Jaw of the Cyprinid Fish Genus *Pseudorasbora*

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In the teleosteans, the upper jaw articulates with the cranium in two regions: anteriorly, the palatine gains articulation with the lateral aspect of the preethmoid bone and there is also a ligamentary connection of the palatine in front of this; posteriorly, the hyomandibula articulates by a single or double head with the sphenotic-pterotic region. This is the methyostylic suspension.

While examining the skulls of fishes of the subfamily Gobioninae (Cyprinidae), I noticed in *Pseudorasbora parva* (Temminck and Schlegel) an interesting additional articulation of the upper jaw. Besides exhibiting the palatine (Fig. 1: ligament facet; preeth. fac.) and hyomandibular (hyomand.) articulations, the upper jaw of *Pseudorasbora* has also gained an articulation by its entopterygoid (entoptery). The latter has a prominent process (prevom. facet) mesially, slightly anterior to its joint with the palatine, by which it articulates with a well-developed facet on the prevomer. This articulation is just behind that of the palatine with the lateral face of the preethmoid.

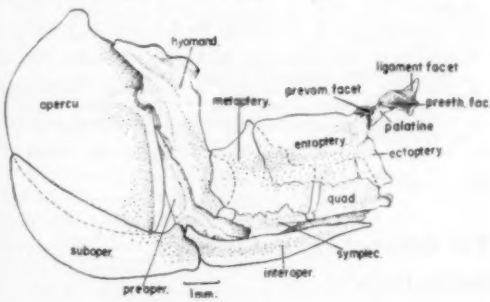


FIG. 1. Mesial aspect of the upper jaw of *Pseudorasbora parva*.

The entopterygoid and palatine articulations are both anterior to the lateral ethmoid bone. Exactly how this additional strengthening is helpful to the animal is difficult to say. The fish lives in placid waters, and therefore the new joint may not be adaptational. Even the young of *Pseudorasbora* show the presence of a typical entopterygoid-prevomer joint.

As far as I am aware, the entopterygoid articulation of the upper jaw with the prevomer in the ethmoid region has so far not been recorded for any fish.

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[2] My sincere thanks go to George S. Myers for many helpful suggestions and for placing the necessary material at my disposal.

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Manuscript received April 2, 1953.

## Synergism and Antagonism of Auxin by Antibiotics[1]

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Various compounds have been found to increase the activity of auxins and others to inhibit or reverse their action (*1–3, 6, 8–10*). This report is concerned with similar effects produced by antibiotics. Three methods were used to test the effects of antibiotics on growth responses of plant materials to indoleacetic acid (IAA): (1) the *Avena* section test of Bonner (*7*), (2) development of cucumber seedlings in sterile agar, and (3) development of cucumber seedlings in moist chambers.

According to the first method, IAA increases elongation of sections of *Avena* coleoptiles floated in the test solution. When used alone, the antibiotics oxytetracycline (terramycin), chloramphenicol, and streptomycin, up to 25 ppm, had no significant effect on elongation, but when used together with IAA (1 ppm) there was greater elongation than from IAA alone. There were no consistent differences in the effects of concentrations of the antibiotics between 1 and 25 ppm. The response to streptomycin in repeated tests was more variable than that to the other two compounds. Citrinin, thiolutin, and clavacin, when used alone, inhibited elongation somewhat, but when used with IAA they reduced the growth-induc-

[1] Journal Series Paper, N. J. Agricultural Experiment Station, Rutgers University, The State University of New Jersey, Department of Microbiology.

TABLE 1

INFLUENCE OF IAA AND CITRININ ON DEVELOPMENT OF PRIMARY ROOTS OF CUCUMBER

| Citrinin | Mean length of primary root, mm* | |
|---|---|---|
| | No IAA | 0.5 ppm IAA |
| 0 | 66.5 | 41.2 |
| 1.0 | 60.6 | 42.9 |
| 2.5 | 63.5 | 52.0† |
| 5.0 | 65.5 | 51.1† |
| 10.0 | 56.7 | 47.4 |
| 25.0 | 51.3 | 44.1 |

* 20 seeds in each series.
† Reversal significant at 0.05 level.

ing effects of the auxin. Gliotoxin and rimocidin had no appreciable effect either alone or with IAA.

In the second method, the seedcoats of cucumber seeds were removed and the seeds were surface sterilized and planted aseptically on the surface of tubes of agar gel containing $M/30$ phosphate buffer of pH 6.0. The agar remained otherwise untreated in some cases, whereas in others IAA or antibiotics or both were added. With IAA at 0.1 ppm or less there was no apparent effect on the seedlings, but at higher concentrations there was root inhibition that increased with increases in the amount of IAA. At concentrations of 5–50 ppm IAA there was inhibition of the hypocotyl as well. Both oxytetracycline and clavacin at concentrations of 5–25 ppm reduced growth of roots and hypocotyl. When either material was used with IAA (0.5 ppm) the toxic effect was greater than that of the material without IAA. Streptomycin had little effect on seedling development either alone or in combination with IAA. As in the *Avena* section test, the effect of citrinin was opposite that of oxytetracycline. When used alone, citrinin had no apparent effect at 10 ppm, but when used with IAA (0.5 ppm) it partly reversed the inhibitive effects of IAA; the primary root was longer and laterals developed, whereas they were absent in the substrate that contained IAA alone.

In the moist chamber tests, cucumber seeds were placed in Petri dishes lined with filter paper moistened with the test solution. From 1 to 25 ppm citrinin was used in the test solution, either alone or with 0.5 ppm IAA. Measurements of roots were made after incubation in the dark at 28° C for 75 hr. Development of the primary root was apparently inhibited by the higher concentrations of citrinin used alone, but the differences were not statistically significant (Table 1). When used together with IAA, citrinin apparently partly reversed the inhibitive effect of IAA on growth of the primary root at concentrations of 2.5–25 ppm, but the reversal was statistically significant only at 2.5 and 5 ppm. Citrinin also partly reversed the inhibitive effect of IAA on development of lateral roots.

There were differences in the response of the seedlings to different concentrations of citrinin in the tests carried out in agar and in the moist chambers. For example, at 0.5 ppm IAA, development of the primary root was almost completely inhibited in the agar substrate, whereas it was fairly good in the moist chambers. These differences are ascribed to differences in the degrees of contact of the roots with the substrate under the two conditions; there was less contact of the roots with the substrate in the moist chambers.

The results provide evidence that antibiotics affect auxin action in distinctly different ways. Two types of effects received particular consideration: (1) A synergistic effect was most evident by the *Avena* section test with oxytetracycline and chloramphenicol; the effect was less pronounced with streptomycin. A suggestion of an increase in the auxin effect was noted also with these antibiotics in the seedling test, where development was inhibited. (2) The second effect was reversal or inhibition of auxin action (antiauxin) by citrinin. This effect was most evident by the seedling test, but was also indicated by the *Avena* section test.

The effects of antibiotics on auxin action may become of practical importance if antibiotics are used to control plant diseases (*2*) or to increase the rate of plant growth (*3*).

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Manuscript received June 17, 1953.

## The Odors of Optical Isomers


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The reports that certain pairs of optical antipodes display different odors have been cited as arguments against the Beck-Miles (*1*) infrared theory of olfaction in its original form. We have reinvestigated one such pair of optical isomers and have failed to confirm the original results (*2*).

The examples investigated, the *d* and *l* dimethyl *trans* hexahydrophthalates, were chosen because they

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[2] The able assistance of Mrs. R. P. Conger is gratefully acknowledged.

seemed to offer the greatest possibility of freedom from chemical difficulties. All other reported instances have concerned substances isolated from natural sources, or compounds such as alcohols and olefins which are susceptible to rearrangements and other reactions which leave the purity and even the structures of the preparations in doubt. Even in the case chosen, however, which appeared to us to be the most favorable, we find that the earlier report of a difference in odor between the two isomers is in error owing to the presence of an unanticipated impurity in one of the samples.

A method of synthesis for the *trans* hexahydrophthalic acid (cyclohexane-1,2-dicarboxylic acid) dimethyl esters differing from that employed by Werner and Conrad (*2*) was chosen, both for reasons of convenience and in the hope that, if accidental impurities were encountered in either method, they might differ in the two routes and lead to nonconcordant results and therefore be apprehended.

Butadiene was bubbled into molten maleic anhydride at 100–110° until absorption ceased, and the resultant *cis* 4-cyclohexene-1,2-dicarboxylic anhydride[3] was crystallized from hexane. The product, m.p. 104°, was hydrogenated in acetic acid, using platinum oxide catalyst. After removal of the catalyst and solvent, the crude saturated anhydride was dissolved in one volume of concentrated sulfuric acid and heated at 100° for 1 hr. An equal volume of water was then added, and heating continued at 150° for an additional hour. Upon cooling, the *trans* cyclohexane-1,2-dicarboxylic acid separated and was recrystallized from water, m.p. 231–232°.

The racemic acid was resolved with quinine according to the directions of Werner and Conrad (*2*). The *d*-acid quinine salt which separated first from methanol was recrystallized several times from that solvent. The acid was liberated with sulfuric acid, taken up in ether, and recrystallized twice from a minimum quantity of water, m.p. 183.5–184°.

The *l*-acid was obtained by evaporation of the mother liquors from the crystallizations and extraction with ether. It was crystallized only once from water, and had a slightly lower melting point than the *d* isomer, 178–180°.

The dimethyl esters were prepared from the acids by reaction with excess diazomethane in ether and isolated by distillation. Both esters boiled at 250° (740 mm).

The *d* dimethyl *trans* cyclohexane-1,2-dicarboxylate (hexahydrophthalate) was thus obtained as a colorless oil with a faint pleasant odor somewhat like that of spearmint. The rotation of the pure liquid in a 1 d. tube was +24.0°; $d_4^{20}$ 1.100 : $\alpha]_D$ +21.8°. In acetone, $\alpha]_D$ +29.7° (10%).

The *l* ester as obtained in the original distillation had an odor that was considerably stronger than that of the *d* ester, and of a different character, more like that of peppermint. The rotation of the undiluted liquid was −20.6°. In acetone, $\alpha]_D$ −25.5° (10%).

The infrared spectrum of the *l* ester was almost the same as that of the *d* ester, but had an additional small maximum at 14.0 μ. The area under this band was only about 0.1% of the total area under the absorption curve from 2 μ to 15 μ. The *l* ester was therefore carefully refractionated. A small forerun (about 1% of the total) was obtained that had a strong odor and displayed a pronounced maximum at 14 μ, plus some additional lower maxima which had not appeared in the original spectrum on the *l* ester, all superimposed on the spectrum characteristic of the hexahydrophthalate. A large intermediate fraction resembling the original sample of *l* ester distilled next, followed by a small fraction which lacked the 14 μ feature. The spectrum of this highest boiling fraction was identical in every respect with that of the *d* ester. Furthermore, its odor was indistinguishable from that of the *d* ester.

The odor of the low boiling fraction was reminiscent of that of methyl benzoate. The infrared spectrum of methyl benzoate was determined, and the prominent peak at 14 μ, together with coincidence of certain other features, makes it appear likely that this is indeed the impurity present in the crude *l* ester.

Pure samples of the *d* and *l* dimethyl *trans* hexahydrophthalates have odors that are indistinguishable qualitatively and seem to be of comparable intensity. Our crude sample of the *l* ester had a noticeably different odor, but one which fits the description given by Werner and Conrad for their sample of *l* ester. The synthetic routes were different, but a common feature of both investigations was the resolution with quinine. It seems probable that a trace of benzoic acid in the quinine used was responsible in both cases for the impurity of the once-distilled *l* ester. The concentration of the impurity was estimated to be 1% or less.

We have checked cursorily one other system, that of *d*-limonene and dipentene (*d,l*-limonene). Commercial samples of these two do display different odors, but the infrared spectrum of the dipentene used (Eastman Kodak, white label) had several peaks not present in the spectrum of the *d*-limonene (Eastman Kodak, blue label). Excluding an unusual solvent effect, the dipentene sample therefore contained more than *d*- and *l*-limonene.

In view of these results, we would be reluctant to believe that any two optical isomers have different odors, unless a more carefully authenticated example should be discovered in the future. Though this tends to vitiate one of the strongest arguments against any radiation theory of olfaction, it must be pointed out that our results should not be interpreted as supporting such theories in any way.

[3] This compound has since become commercially available.

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Manuscript received July 6, 1953.

# Comments and Communications

## A Punch Card for Abstracts of Bacteriological Papers

THE use of punch cards (Fig. 1) has provided a satisfactory solution to the problem of filing and cross-indexing abstracts of bacteriological papers. The card reproduced in Fig. 1 contains subject headings concerning antibiotics and enzymes simultaneously may be extracted by running a stylus through the hole opposite the heading *enzymes*. The selection of abstracts could be made even more specific by extracting only those abstracts which deal with the *Streptococceae*.

The headings in the classification section are not

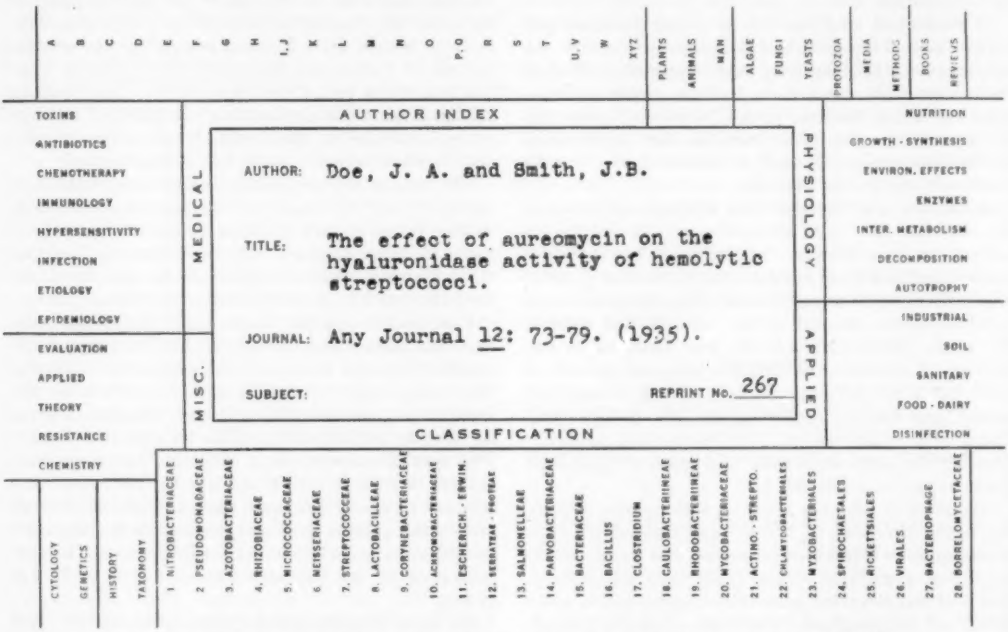


FIG. 1. Punch card for abstracts of bacteriological papers. A hypothetical example is illustrated.

selected to cover all phases of bacteriology and has been successfully used by four bacteriologists of widely divergent interests. The card measures 5 × 8 in. The citation appears on the front of the card while the back is reserved for the actual abstract. The hole opposite each subject heading that applies to the particular paper is punched out to the margin of the card. Thus, in the fictitious example shown, *D* is punched for the senior author, J. A. Doe; antibiotics, enzymes, and *Streptococceae* are punched as the paper deals with the antibiotic aureomycin, the enzyme hyaluronidase, and a genus in the tribe *Streptococceae*, respectively.

To select abstracts dealing with any desired subject one need only insert a stylus through the hole opposite that subject heading in the stack of abstracts and lift the cards. Those cards dealing with the desired subject will drop out of the stack. Thus all abstracts that deal with the general subject of antibiotics can be rapidly selected. From this collection those references all of coordinate taxonomic position but are divided into units according to their relative frequency of use. In some instances an entire order was assigned to one hole, e.g., *Myxobacteriales*. In most cases in the *Eubacteriineae* the family names were used, e.g., *Neisseriaceae*. Large families were listed according to tribes, e.g., *Salmonelleae*, while the commonly encountered genera *Bacillus* and *Clostridium* were assigned individual holes. In actual use the order *Virales* can be readily divided into plant or animal viruses by simultaneously punching the hole opposite the heading plants or animals, respectively. The bacteriophages were allotted a separate hole. The type of bacteriophage can be readily designated by punching the classification heading of the host bacterium.

Each card has 16 holes without assigned subjects. These holes can be used for the special subject interests of an individual; the subject heading can be written on a master card. The card shown in Fig. 1 has a space on the face of the card for *Subject*. This

space is used if the paper abstracted includes a subject, of particular interest to the abstractor, that is not clearly designated in the title of the paper. Space is also provided for *Reprint No.* The authors number each of their reprints as received and file them in numerical sequence. This number is recorded on the abstract card for that paper. Since the abstract of any paper can be found in less than one minute, the exact location of the reprint can be determined very quickly.

The large number of combinations of subject headings possible on these punch cards provides for a much finer subdivision of subject matter than is practicable by the usual method of cross-indexing abstract cards. In addition, the time required to cross-index and file abstract cards is eliminated, as the cards need not be filed in any particular order. Space requirements are reduced since no cross-indexing cards are needed. Although the cards described here were designed for use by bacteriologists, similar cards could be readily adapted for use by scientists in other fields.

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Received July 7, 1953.

## "Data"

DR. BACHARACH (SCIENCE, **117**, 537 [1953]) surely wishes to restrict unduly the meaning of the useful word "data." The primary products of an experiment are the numerical or other abstractions known as its results. When these are transferred from a recording instrument on a bench to a sheet of paper on a desk they become the data which the experiment has *given* towards the construction of a theory or course of action. Experimental results are raw materials; experimental data are about to be put to use.

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Received June 15, 1953.

## The Research Committee in the Organization of the International Biological and Medical Associations and their Congresses

THE Research Committee established by the International Association of Gerontology in 1951 might suggest a similar organization in other international biological and medical congresses.

At present the usual organization of these congresses does not completely satisfy all the active research workers. There is no doubt that the present congresses do important work. Such congresses, however, contribute comparatively little to the *rapid* progress of research work, since the reports, irrespective of whether they are reported at the congresses or not, are published in various scientific journals, in which they can be studied more carefully than is possible at the congresses themselves. Their basic deficiency, however, is in the fact that at the usual congresses only the results of research already performed are reported, while for the solution of every problem a carefully devised research scheme and methods are of primary importance. To devise a perfect research scheme is very difficult indeed.

The point is that usually every research worker likes to approach any problem from his particular angle and to use his particular methods and tests for its solution. Such a "one-track approach" limits his research scheme, in some cases, to such an extent that it becomes impossible for him to arrive at definite conclusions; while some additional line or method in his research would allow him not only to obtain wider and more numerous results, but also to use his energy, time, and money in a more economical and productive way.

Therefore, at first during the last war, special Research Committees, consisting of the best specialists in various countries, were established (for example, for splitting the atom). At meetings of these Committees the research schemes and methods necessary for the solution of the proposed problems are considered at round-table discussions by a number of specialists. Each one considers the research project from a different angle and proposes different research methods. In this way the best possible and the most comprehensive research schemes and methods for any project can be worked out.

Of course, the author of the project is at complete liberty to accept the suggestions made at the round-table discussions or to reject them.

*Permanency in the work of Research Committees.* It is desirable that, during the whole duration of the Congress, the Sessions of the Research Committee be held separately from, but simultaneously with, the usual Sessions, so as not to interfere with the activity of the latter. The Research Sessions will be of great importance and interest only to a comparatively small group of active research specialists. However, on this small number of specialists the solution of all the biological and medical research problems depends completely; and also of all the socio-economic and other practical problems related to them (as for example in the case of gerontological socio-economic problems).

The sessions of these committees have to be arranged not only during the congresses, but also between the congresses. The financial difficulties indicate that these "between sessions" should be local, for example, conferences of the American and European Divisions of the Committee. These major local conferences can be further subdivided into meetings of small groups of specialists in each country who, at the general conferences, have found that in their current research work they are interested in the same limited line of research.

*The Research Committee on Biology and Medicine of the International Association of Gerontology.* The Committee was established by the Association in 1951, during the 2nd International Gerontological Congress in St. Louis. A little later the whole Research Committee was organized, with subcommittees on Cellular Biology, Endocrinology, Pathology, Nutrition and Metabolism, and Clinical Pathologic Physiology. Since it appears to be the first of its kind in the activity of the medical and scientific associations, it can be considered as an experiment. When put into wider practice, the committee might introduce some improvements into its organization. The participants of the committee already consider it to be a definite success.

All the details of the establishment and activities of the committee are given in the report on the subject to the 2nd International Gerontological Congress (*1*), the Proceedings of the Endocrinological Session of the Congress (*2*), and the Proceedings of the Conference of the European Division of the Committee (*3–5*).

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Received February 17, 1953.

## *Lepidurus kirkii*

LINDER (*1*) refers to a view that there is a biological difference between the branchiopods, *Apus* and *Lepidurus*; the former occur in pools that dry up, the latter are found in permanent water. He writes of having seen *L. apus* in ponds in Sweden which dry up every year, and he refers to reports by others about both genera.

It is evident that relevant data on *Lepidurus* are rather scanty and the following may be placed on record: On Marley's Hill, near Christchurch, New Zealand, are three ponds nearly equidistant and roughly in line north to south. The southernmost pond dries up annually, the other two have not been known to dry up in the past twenty years. *L. kirkii* appears regularly, annually, in the temporary pond.

In the permanent ponds, rare occurrences of two or three, or some greater small number of *L. kirkii* have been noted sometimes at intervals of several years, and are quite clearly accidental. These latter mature specimens grow to an enormous size, three times that of those in the temporary pond. They probably live a long time. There is no evidence that they have any progeny. Their presence may be caused by the carriage by the wind of occasional eggs from the dry site to the south, or from some other site.

The conclusion is that the eggs of *L. kirkii* must be dried before they will hatch.

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Received April 23, 1953.

## Food Prices in Palo Alto

IN 1944 and 1948 reports on food prices in Palo Alto, California, were published in SCIENCE, **101**, 124 (1944); **108**, 425 (1948). The surveys, upon which these reports are based, were initiated in 1939 and have been made annually in the 3rd week of May. Since it has been observed that these surveys are of more than local interest, the later data are now presented for publication.

Greater Palo Alto (inclusive of Stanford) may still be described as a university town, now having a population of about 42,000 inclusive of 7200 students and 1000 university employees and members of their families resident on the Stanford campus. Of the wage earners resident in this community, approximately 27% are employed in San Francisco or other neighboring towns, about 10% are employed by Stanford University, and about 22% by light industries in this area. The remainder are engaged in the manifold activities characteristic of such communities. There is no heavy industry in the area.

The survey of food prices referred to here has been made among the retail stores in Palo Alto, in all cases during the 3rd or 4th week of May. Year by year the same items were priced. To give a proper weighting to the list, the quantities of various foodstuffs required for a "liberal" diet were used. The cost of such a diet was determined for one week's maintenance of an adult man engaged in moderate physical activity. It is recognized, of course, that many different liberal diets could be devised, though all would be characterized, according to present concepts, by being comparatively low in potatoes and highly processed cereals and comparatively rich in so-called high quality protein foods. The particular diet that we have priced contains an abundance of dairy products, fresh fruits and vegetables, and high quality proteins. It is not, however, a "luxury" diet. Differences in regional dietary practices or in availability of foodstuffs would permit many variations without serious trespass upon the limiting characteristics of a liberal diet. The particular foods about which these surveys have centered would provide, per day, approximately 3100 Cal, 137 g fat, 318 g carbohydrate, 107 g of protein, 1.36 g calcium, 2.04 g phosphorus, 20 mg iron, 15,000 units of vitamin A or its equivalent, 160 mg ascorbic acid, 370 units of vitamin D, 1.4 mg of thiamin, and 2.7 mg of riboflavin. These values refer to the food as purchased and should be reduced by probably 10% to

reflect the values for food as consumed. The list of foods, per adult per week, is as follows:

| | | | |
|---|---|---|---|
| Bread | 1 lb | Sweet potatoes | 1 lb |
| Oatmeal | 0.5 " | Potatoes | 3 " |
| Cornmeal | 0.5 " | Cabbage | 2 " |
| Sugar | 1.2 " | Lettuce | 0.5 " |
| Milk | 3.5 qt | Carrots | 1 " |
| Cheese | 0.75 lb | Beets | 1 " |
| Butter | 0.5 " | Canned corn | 0.5 " |
| Eggs (large, grade A) | 1 " | Oranges | 2 " |
| | | Apples | 1 " |
| Lard | 0.25 " | Bananas | 1 " |
| Bacon | 0.25 " | Dried prunes | 0.5 " |
| Beef chuck roast | 2.5 " | Canned peaches | 0.5 " |
| Salmon | 1 " | | |

Five stores were included in the 1939 survey, 6 in 1940, 7 in 1941, 9 in 1942 to 1952, and 8 in 1953. Three of the stores in the 1939 list and four in the subsequent lists are members of chains. A large cooperative store was included. All small stores were deliberately omitted, as well as one or two stores that cater to luxury trade and are recognized as atypical with respect to distribution costs and retail prices.

In the case of canned goods, the cheapest brands were priced. It is believed that the nutritive qualities were reasonably comparable. To obtain maximum economies in purchasing, quantity prices (up to 10 lb) were used, whenever feasible, as the basis for the calculations (Table 1).

The increases reported since 1939 are not to be considered as indicative of the extent to which the cost of living has increased. This is because cost of living indices include many items other than food and also because liberal diets are low in cereal products (which have increased the least) and rich in fresh vegetables, fruits, fish, eggs, and meat. For example, while bread, sugar, milk, and oatmeal have approximately doubled in price since 1939, the present prices of beef, cheese, butter, and eggs are about three times those of 1939; garden vegetables and potatoes are 3 to 4 times as costly as in the base year; and canned salmon, prunes, and apples are 5 to 6 times as expensive.

TABLE 1

| Year | Average cost at retail price | Percentage increase over 1939 |
|---|---|---|
| 1939 | $2.28 | |
| 1940 | 2.28 | 0 |
| 1941 | 2.96 | 30 |
| 1942 | 3.59 | 57 |
| 1943 | 4.72 | 107 |
| 1944 | 4.26 | 87 |
| 1945 | 4.26 | 87 |
| 1946 | 4.40 | 93 |
| 1947 | 5.96 | 161 |
| 1948 | 6.81 | 199 |
| 1949 | 6.58 | 189 |
| 1950 | 6.10 | 166 |
| 1951 | 7.07 | 210 |
| 1952 | 7.04 | 209 |
| 1953 | 6.65 | 190 |

The prices used for carrots and beets are those for the trimmed vegetables and represent strictly the cost of the edible portion. It is unfortunate that in most cases retail stores still continue to sell these by archaic standards: by the bunch rather than by net weight.

Since fortified margarine is now to be regarded as an acceptable substitute for butter, and tinned mackerel is considerably cheaper than tinned salmon, even though somewhat lower in vitamin A, we have decided in the future to substitute these two items for butter and tinned salmon, respectively, in these dietary surveys. The hamburger now available locally appears to be of higher quality than that sold in 1939, although in composition it is not yet satisfactorily defined. Nonetheless, it is widely consumed. If the list of foods published above were to be amended by the replacement of butter and chuck roast of beef with margarine and hamburger, respectively, the cost of the liberal diet would fall from $6.65 to $5.74 for 1953.

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[1] The assistance of Barbara Davey and Ruth Hoag in collection and compilation of the data is gratefully acknowledged.

Received June 23, 1953.

## Description of a New Technique for Rearing Polychaetous Annelids to Sexual Maturity[1]

The maintenance of developing larvae has been a major problem in life history studies of polychaetous annelids. Many techniques have been devised in the past to overcome it, e.g., the use of finger bowls (*1*), a plankton net sea cage (*2*), a balanced aquarium to which diatom cultures are added (*3*), and the plunger jar system (*4*).

The technique employed by the author utilized the principle of simulation of the natural current conditions. Three to four gallons of sea water were added to a five-gallon all-glass aquarium. Circulation of the sea water was effected by two aquaria stones connected by rubber tubes to a compressed air system and placed at opposite sides of the jar. The aquaria stones break the compressed air into fine bubbles that serve as a means of aerating and circulating the water. In this manner the water was in continuous circulation, which kept the larvae off the bottom and free from attack by bacteria and protozoa. Sea water was collected, filtered, and stored at 4–6° C until needed. The temperature of the water in the aquarium ranged from 18° to 22° C.

Cleaving eggs or trochophores of the polychaete worm, *Nereis grubei* Kinberg, are placed in the aquarium. By the time the larvae are ready to feed, about 2 weeks after fertilization, sufficient diatom growth is present. Dried, ground mussel gonad and thalli of green algae are added periodically to assure

[1] Contribution number 113 from the Allan Hancock Foundation, University of Southern California.

an adequate food supply. The worms can be removed and isolated into Petri dishes after the onset of feeding.

The advantages of the aquarium circulation systems are many. The worms can be reared with a minimum of attention, food can be available without the possibility of contamination as soon as the animal is ready to begin feeding, and large numbers of worms can be reared to sexual maturity. By the use of this technique, the author has reared *N. grubei* successfully through the $F_2$ generation.

DONALD J. REISH

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Received February 10, 1953.

## Glass Needles and Latex

IN an investigation of the fascial spaces of the face and neck, rubber latex was used as an injection material. Unfortunately, when efforts were made to inject various spaces with latex by means of a large syringe and metal needle, the latex always solidified in the needle and would not flow, no matter how high a pressure was used. After consultation, ammonia and other alkalies were first mixed with the latex, but to no avail; it always solidified almost immediately in the needle. The idea then occurred to us to try glass needles made by drawing out a glass tube over a Bunsen burner. Very surprisingly the rubber flows perfectly through them. The latex solidifies in any metal needle but flows freely through a glass needle of the same bore. We venture no explanation of this phenomenon, but since the fact is not apparently well known, this note may save others from considerable trouble and disappointment.

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Received May 4, 1953.

## The Use of Enzymes in Sulfa Drug Analysis

IT has been noted that some samples of medicated chicken feed containing sulfaquinoxaline upon long standing suffer an apparent loss of sulfaquinoxaline when analyzed by the AOAC tentative procedure (*1*) (extraction with caustic and colorimetric determination using the Bratton-Marshall method [*2*]). These same feeds, however, appeared to be as efficacious in the treatment of coccidiosis as freshly prepared feeds. This led to the assumption that sulfaquinoxaline was being bound in the feed, possibly to the protein, in such a way that it was available to the chicken as a coccidiostat but was not extracted quantitatively by the AOAC procedure. It was found that a short digestion of the feed with ficin, a proteolytic enzyme occurring in the latex of the tropical tree Ficus, would release the so-called bound sulfaquinoxaline and it could be quantitatively determined by the usual procedure. Other enzymes may behave in a similar manner, but have not been tried to date. As typical examples of the assay results we offer:

| Sample | Theory | Original date | Current assay date | Per cent SQ | |
|---|---|---|---|---|---|
| | | | | AOAC | Ficin |
| Synthetic | | | | | |
| A | 0.0150% | 2/53 | 2/53 | 0.0130 | 0.0150 |
| B | 0.0163 | 2/53 | 2/53 | 0.0145 | 0.0170 |
| Commercial | | | | | |
| 1 | 0.0125 | 1/52 | 2/53 | 0.0086 | 0.0124 |
| 2 | 0.0125 | 1/52 | 2/53 | 0.0070 | 0.0115 |
| 3 | 0.0125 | 3/52 | 2/53 | 0.0088 | 0.0103 |

In these experiments a 5-g sample is shaken for 30 min with 100 ml of 0.1% ficin, then 5 ml of 0.5 *N* NaOH added and shaken for an additional 15 min. The mixture is made up to 250 ml and centrifuged. A 50-ml aliquot is shaken with 3 ml of concentrated hydrochloric acid and made up to 100 ml and filtered. The color is then developed on a 15-ml aliquot by the Bratton-Marshall procedure.

It is recommended that other investigators who are interested in the problem of assaying the sulfa drugs in the presence of protein might investigate the use of ficin or some other proteolytic enzyme.

C. R. SZALKOWSKI
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*Rahway, New Jersey*

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2. BRATTON, A. C., and MARSHALL, E. K., JR. *J. Biol. Chem.*, **128**, 537 (1939).

Received June 10, 1953.

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*Correction.* In the paper "A New Series of Highly Active Local Anesthetics" (SCIENCE, **118**, 138 [1953]), in Table I, fourth column "Topical cocaine ratios: Corneal (rabbits)," the value for WIN 4510, the most active compound in the series, should read *500* instead of *1000*.

F. P. LUDUENA

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# Book Reviews

***Dynamical Oceanography.*** J. Proudman. London: Methuen; New York: Wiley, 1953. 409 pp. Illus. $8.50.

When one considers the extensive publicity given oceanographic expeditions by the press, the astonishing success of popular books concerning the marine sciences, the large sums expended in oceanographic research (about $5,000,000 a year), he will be surprised to realize that Professor Proudman has provided us with the *first* text on theoretical oceanography in the English language. It is now possible for any physical scientist to obtain an idea of the theoretical framework of oceanography in terms that he can appreciate. Until the publication of this work, a physicist seeking information about the ocean was without an adequate guide to such theoretical literature as does exist and might easily suffocate in the mass of qualitative reasoning that characterizes so much of the professional literature.

The only prior English language treatise that does exist (*The Oceans,* Sverdrup *et al.,* Prentice-Hall, 1942) is a compendium covering all branches of marine science (biology, chemistry, etc.) in which the physical portions are written in a form more suited for meteorologists and the professional oceanographer than for physical scientists.

The first three chapters of *Dynamical Oceanography* are an introduction to the hydrodynamical equations in a rotating reference frame. Chapter 4 is concerned with the standard gradient current approximation so much used for computing the field of motion from the observed density structure. Chapter 5 treats various examples of stationary accelerated current systems. Chapters 6 and 7 deal with the subject of ocean turbulence and mixing processes. A very original treatment of the role of friction in the dynamics of parallel currents is introduced in Chapter 8. The following chapter begins with an ingenious explanation of the asymmetry of the wind-driven surface circulation, discusses the classical wind-drift current theory of Ekman and the many subsequent studies inspired by Ekman's work. Chapter 10 is unique in the oceanographic literature: it grapples with the difficult thermodynamical circulations in the ocean.

In Chapters 11–14 Professor Proudman enters into the subject of tides, where he is the world's foremost authority. Chapter 15 is an exposition of internal tides and waves. The final chapter is a brief summary of the main results of classical surface wave theory.

The exposition is clear and concise, and the book is so arranged that one may read any chapter at will without having to refer constantly to equations in previous chapters. Many readers will be glad to hear this.

This book should prove particularly useful for teachers of oceanography because each subject is discussed in a series of examples of increasing complexity, and in most cases the proofs and demonstrations are entirely original and novel. There is a short history and bibliography at the end of each chapter. These references contain few works of recent date, but this was perhaps a necessary restriction in order to maintain a well-balanced presentation of the entire subject, many aspects of which are so difficult that little progress has been made for many years. For example, a satisfactory model of the meridianal thermohaline circulation has never been investigated chiefly because of the essentially nonlinear nature of the transfer equations. Or, as another example, it has been impossible to integrate the linear tidal equations for the real oceans because the geometry of the ocean basins is so irregular. There is also a great deal to be said for giving references to original works, rather than to recent elaborations, no matter how old the original works happen to be.

The serious reader will find it desirable to supplement his study of Proudman's book with reading of a more descriptive nature. This reviewer recommends for this purpose the chapter on "water masses" in Sverdrup's *The Oceans.*

For years physical oceanography has been something of an ugly duckling among other prouder, established sciences. To many an academic scientist it seemed a species of geographical exploration, an expensive hobby for amateurs like the Prince of Monaco, or a minor adjunct to marine ecology. This unfortunate impression was largely due to the chaotic state of its theoretical framework. Professor Proudman's book presents this material in an orderly, understandable fashion and ought to do much in attracting the attention of capable mathematicians and physicists to the many perplexing theoretical problems of the ocean. Publication of this splendid volume makes one feel that oceanography has at last come of age.

HENRY STOMMEL
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*Woods Hole, Massachusetts*

***Fundamentals of Limnology.*** 2nd ed. Franz Ruttner; trans. from German by D. G. Frey and F. E. J. Fry. Toronto: Univ. Toronto Press, 1953. 242 pp. Illus. $6.50.

Usually a foreign text is translated some years after its appearance, by which time it is already beginning to show signs of age. This might have been the fate of this translation had the translators been unable to work from the manuscript of Ruttner's revised edition. The result is an up-to-date English version, published within a year of the new German edition, a circumstance as rare as it is welcome

The virtues of a text are often not apparent until it has been subjected to use by a group of students; the faults, such as major errors and omissions, may be apparent immediately. There are few omissions in

this concise book unless the comparatively sparse treatment of springs and streams as compared with lakes is considered an omission, but then this is intended to be a treatment of the *fundamentals*, not the details, of limnology, with particular reference to water as an environment. The use of European examples is of course natural, but the translators might have added a few more footnotes (they have not, incidentally, clearly separated their own from those by the author in all cases) citing examples to round out the work for use on this continent. Although that might be considered the duty of the lecturer who uses this for a text, it must be remembered that such a book is also consulted and read by students unable to take a course in limnology. It is interesting to note, by the way, that European cognizance of the extensive Russian literature in this field is as incomplete as our own. The book includes a glossary of terms, as well as a list of German-English equivalents, a condensed bibliography, and a very good index.

JOEL W. HEDGPETH
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***Cold Spring Harbor Symposia on Quantitative Biology: The Neuron,*** Vol. XVII. Cold Spring Harbor, L. I., N. Y.: Biological Laboratory, 1952. 323 pp. Illus. $8.00.

This is the most advanced text on a general physiology of the neuron to appear in the international literature. It covers largely physiological investigations on the neurons of vertebrates but the anatomical aspects of the problem of the synapse have not been neglected and several papers deal with experiments on invertebrates.

Bodian discusses the amazing variety in the structural basis of the synapse while Chang correlates anatomical and physiological data in cortical dendrites. Tobias shows that optical changes are associated with nerve conduction and probably related to osmosis. The classical problem of nerve conduction is analyzed by Frankenhaeuser, Gasser, and Tasaki. Hodgkin and Huxley present a summary of their outstanding work on the role of Na and K ions in the process of excitation.

Electrotonic changes in nerves and dorsal roots are studied by Therman, Lloyd, and Lorente de Nó. Brink, Bronk, and their collaborators discuss their ingenious experiments on $O_2$ consumption of the resting and active nerve and show that half a million impulses may be conducted without an increase in the oxygen uptake of the nerve. In addition, Larrabee and Bronk review their extensive work on the metabolism of excised sympathetic ganglia with emphasis on the role of oxygen and glucose. Hunt gives a lucid summary of his work on stretch receptors with emphasis on the role of the small diameter efferent fibers. Two outstanding papers deal with retinal processes. Hartline continues his work on *Limulus* and discusses his beautiful experiments on a single ommatidium under the influence of light. Kuffler introduces new methods for the study of single action potentials in the mammalian retina and emphasizes the organization of the receptive retinal field. Skoglund contributes to the theory of neurohumors by studying the effects of acetylcholine and adrenalin on action potentials in spinal reflexes.

The book is well printed and illustrated. Unfortunately, the discussion is very limited. This is surprising in view of the fact that a relatively large international group of experts in neurophysiology participated in this Symposium. Is this an expression of a rather unhealthy state of specialization?

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## *Scientific Book Register*

***Centennial of Engineering.*** History and proceedings of symposia of American Society of Civil Engineers, 1852–1952. Lenox R. Lohr, Ed. Chicago: Museum of Science and Industry, 1953. Illus. + plates.

***Basic Bacteriology: Its Biological and Chemical Background.*** Carl Lamanna and M. Frank Mallette. Baltimore: Williams & Wilkins, 1953. 677 pp. Illus. $10.00.

***Electrical Engineering: Essential Theory and Typical Applications.*** 2nd ed. Fred H. Pumphrey. New York: Prentice-Hall, 1953. 404 pp. Illus. $6.00.

***Pituitary Chromophobe Adenomas: Neurology, Metabolism, Therapy.*** A clinical study of the sellar syndrome. John I. Nurnberger and Saul R. Korey. New York: Springer Pub., 1953. 282 pp. Illus. $7.00.

***Railroad Engineering,*** Vol I. William W. Hay. New York: Wiley; London: Chapman & Hall; 1953. 483 pp. Illus. $7.50.

***The Pluripotency of the Hypophyseal Hormones and the Consequences for Endocrinology and Cancerology.*** Jules Samuels. Amsterdam: N. V. Cycloscoop, 1953. 296 pp. 37 guilders.

***Basic College Chemistry.*** 2nd ed. Joseph A. Babor. New York: Crowell, 1953. 766 pp. Illus. + chart. $5.00.

***Laboratory Problems in General Chemistry.*** Howard Nechamkin. New York: Crowell, 1953. 274 pp. Illus. $2.50.

***College Physics.*** 4th ed. Frederick A. Saunders and Paul Kirkpatrick. New York: Holt, 1953. 603 pp. Illus. + plates. $6.25.

***Child Training and Personality: A Cross-Cultural Study.*** John W. M. Whiting and Irvin L. Child. New Haven: Yale Univ. Press; London: Geoffrey Cumberlege, Oxford Univ. Press, 1953. 353 pp. $5.00.

***Sectional Radiography of the Chest.*** Irving J. Kaue. New York: Springer Pub., 1953. 154 pp. + plates. $7.50.

***The Revolution in Physics.*** A non-mathematical survey of quanta. Louis de Broglie; trans. by Ralph W. Niemeyer. New York: Noonday Press, 1953. 310 pp. $4.50.

***Condensed Pyridazine and Pyrazine Rings*** (Cinnolines, Phthalazines, and Quinoxalines). Chemistry of Heterocyclic Compounds, Vol. 5. J. C. E. Simpson. New York–London: Interscience, 1953. 394 pp. $12.50.

***Trigonometry.*** John F. Randolph. New York: Macmillan, 1953. 220 pp. Illus. $3.00.

***Organic Chemistry.*** 2nd ed. Ray Q. Brewster. New York: Prentice-Hall, 1953. 855 pp. Illus. $7.00.

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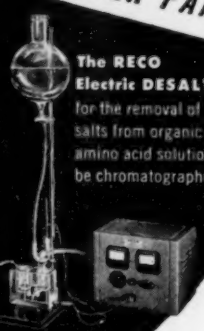

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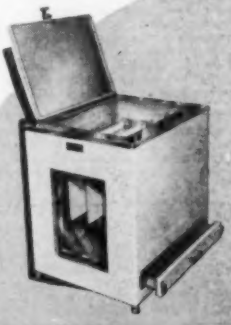

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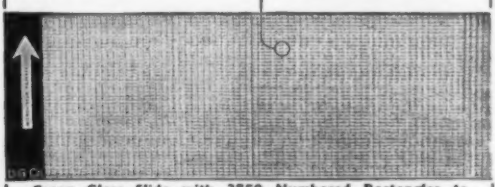

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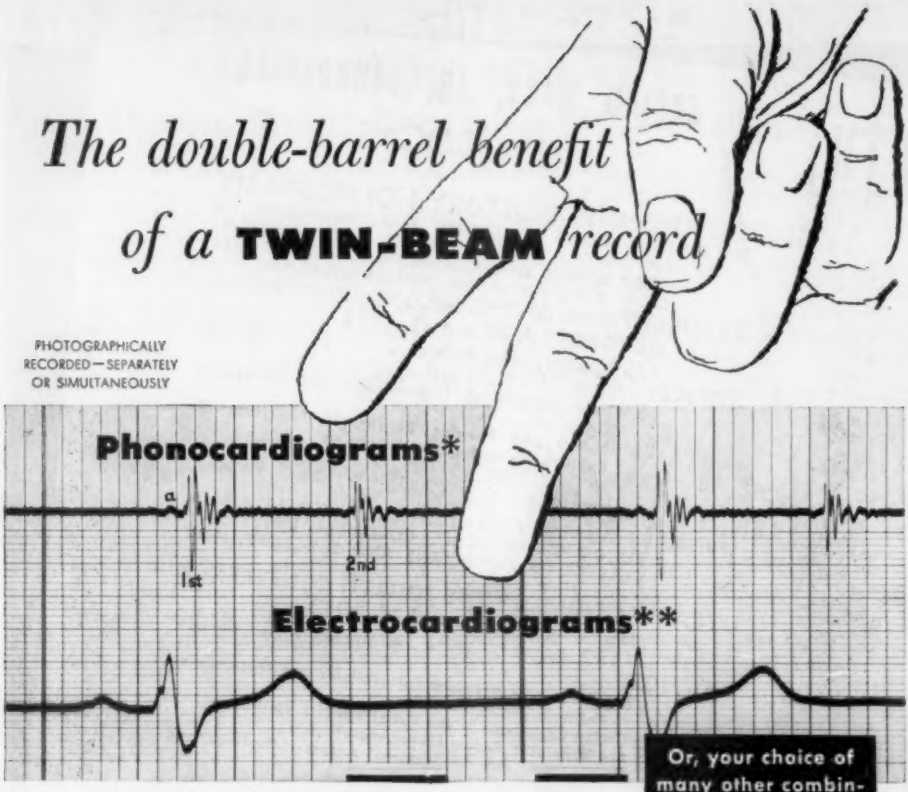


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